National Information Exchange Model Naming and Design Rules

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Editors:

Webb Roberts, Georgia Tech Research Institute

Susan Liebeskind, Georgia Tech Research Institute

Mark Kindl, Georgia Tech Research Institute

Abstract:

This document specifies the data model, XML components, and XML data for use with the National Information Exchange Model (NIEM) version 2.0.

Status:

This document is a draft specification for NIEM-conformant XML components. It represents the design that has evolved from the collaborative work of the NIEM Business and Technical Architecture Committees (NBAC and NTAC) and their predecessors.

This specification is a product of the NIEM Program Management Office (PMO), but has NOT been officially approved by either the PMO or the NIEM governance committees (NBAC and NTAC). The PMO has recommended that this document be published for public review at the same time the PMO, NBAC, and NTAC are reviewing it.

Send comments on this specification via email to `niem-comments@lists.gatech.edu`.

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1. Introduction

This Naming and Design Rules (NDR) document specifies schemas for use with the National Information Exchange Model (NIEM). The NIEM is an information sharing framework based on the World Wide Web Consortium (W3C) eXtensible Markup Language (XML) Schema standard. In February 2005, the U.S. Departments of Justice (DoJ) and Homeland Security (DHS) signed a cooperative agreement to jointly develop the NIEM by leveraging and expanding the Global Justice XML Data Model (GJXDM) into multiple domains. The NIEM is a result of a combined government and industry effort to improve information interoperability and exchange within the U.S. at federal, state, tribal, and local levels of government.

NIEM specifies a set of reusable information components for defining standard information exchange messages, transactions, and documents on a large scale: across multiple communities of interest and lines of business. These reusable components are rendered in XML schemas as type, element and attribute definitions that comply with the W3C XML Schema specification. The resulting reference schemas are available to government practitioners and developers at `http://niem.gov/`.

The W3C XML Schema standard enables information interoperability and sharing by providing a common language for describing data precisely. The constructs it defines are basic metadata building blocks – baseline data types and structural components. Users employ these building blocks to describe their own domain-oriented data semantics and structures. Rules that profile allowable XML Schema constructs and describe how to use them help ensure that those components are consistent and reusable.

This document specifies principles and enforceable rules for NIEM data components and schemas. Schemas and components that obey the rules set forth here are considered to be **NIEM-conformant**.

1.1. Scope

This document is a specification for NIEM 2.0. It is not intended to specify beyond the NIEM 2.0 release. The document covers the following issues in depth:

- The underlying NIEM data model
- Guiding principles behind the design of NIEM
- Rules for using XML Schema constructs in NIEM
- Rules for modeling and structuring NIEM-conformant schemas
- Rules for creating NIEM-conformant instances
- Rules for naming NIEM components

This document does NOT address the following:

- A formal definition of the NIEM data model.

  Such a definition would focus on the Resource Definition Framework (RDF) and concepts not strictly required for interoperability. This document instead focuses on definition of schemas that work with the data model, to ensure translatability and interoperability.

- A detailed discussion of NIEM architecture and schema versioning.

  Such rules will be addressed in **[ARCH]**.

- The artifacts of the NIEM information exchange process.

  The artifacts of the NIEM information exchange process are discussed in **[IEPD]**.

This document is intended as a technical specification. It is not intended to be a tutorial or a user guide. A brief NIEM Overview is provided in Appendix A.

1.2. Audience

This document is targeted at government practitioners and developers who employ XML for information exchange and interoperability. Such information exchanges may be between organizations or within organizations. The NIEM reference schemas provide system implementers much content on which to build specific exchanges. However, there is a need for extended and additional content. The purpose of this document is to define the rules for such new content so that it will be consistent with the NIEM reference schemas. These rules are intended to establish and, more importantly, enforce a degree of standardization on a national level.

1.3. Document Conventions

This document uses formatting and syntactic conventions to clarify meaning and avoid ambiguity.

1.3.1. Document References

This document relies on references to many outside documents. Such references are noted by bold, bracketed inline terms. For example, a reference to RFC 2119 is shown as **[RFC2119]**. All reference documents are recorded in Appendix I, References.

1.3.2. Normative and Informative Content

This document includes a variety of content. Some content is normative (binding and enforceable in implementations), while other content is informative (explanatory, but not part of the NIEM specification). In general, the informative material appears as supporting text and specific rationales for the normative material.

Conventions used within this document include:

[Definition: <*term*>]

A formal definition of a term associated with NIEM.

Definitions are normative.

[Principle <*number*>]

A guiding principle for NIEM.

The principles represent the requirements, concepts, and goals that have helped shape the NIEM. Principles are informative, not normative, but act as the basis on which the rules are defined.

Principles are accompanied by a short discussion section that justifies the application of the principle to NIEM design.

[Rule <section>-<number>]

An enforceable rule for NIEM.

Rules state specific requirements on artifacts, such as schemas and instances. Most rules apply to conformant schemas while others apply to instances. The rules are normative.

Rules are stated using both XML InfoSet terminology (elements and attributes) and XML Schema terminology (schema components). The choice of terminology is driven by which standard best expresses the rule. Certain concepts are more clearly expressed using XML InfoSet information items, others using the XML

Schema data model, and still others are best expressed using a combination of terminology drawn from both standards.

Rules have rationales which justify the need for the rule. For clarity, there may be multiple rules which have the same rationale.

Rules and supporting text may use Extended Backus-Naur Form (EBNF) notation as defined by **[XML]**.

Rules are numbered according to the section in which they appear, and the order in which they appear within that section. For example, **[Rule 4-1]** is the first rule in Section 4. Rule identifiers that are deleted or re-categorized will not be reused until a major release milestone is reached, at which point all identifiers may be reset.

1.3.3. Formatting

In addition to special formatting for definitions, principles and rules, this document uses consistent formatting to identify NIEM components.

`Courier`: All words appearing in `Courier` font are values, objects, keywords, or literal XML text.

Italics: All words appearing in *italics*, when not titles or used for emphasis, are special terms with definitions appearing in this document.

Keywords: Keywords reflect concepts or constructs expressed in the language of their source standard. Keywords have been given an identifying prefix to reflect their source. The following prefixes are used:

- `xsd:` identifies keywords from the W3C XML Schema Definition Language specification.
- `xsi:` identifies keywords from the W3C XML Schema's XML Schema Instance specification.
- `structures:` identifies keywords from the NIEM structures namespace.
- `appinfo`: identifies keywords the NIEM appinfo namespace.

Throughout the document, fragments of XML schema or XML instances are used to clarify a principle, or rule. These fragments are specially formatted in `Courier` font, and appear in text boxes. An example of such a fragment would appear like this:

```
<xsd:complexType name="PersonType">
  ...
</xsd:complexType>
```

1.4. Terminology

This document uses standard terminology to explain the principles and rules that describe NIEM.

1.4.1. RFC 2119 Terminology

Within normative content (rules and definitions), the key words MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, MAY, and OPTIONAL in this document are to be interpreted as described in **[RFC2119]**

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1.4.2. XML Information Set Terminology

This document uses the concepts of element information items (“element”) and attribute information items (“attribute”) and their associated properties as defined by **[XMLInfoSet]** with clarifications as discussed below. Note that in the clarification that follows, the abstract property names appear in square brackets relative to the information item to which they belong. For example, “Element[parent]” discusses the abstract property “parent” of the element information item.

- parent of an element (Element[parent])

  child of an element (Element[children])

  Note that the InfoSet properties “Element[parent]” and “Element[children]” correspond to a direct, immediate relationship with an element. Children of an element, and their children, and so on, will be collectively referred to as "descendants" of that element. Parents of an element and their parents, and so on, will be collectively referred to as “ancestors” of that element.

- element owning an attribute (Attribute[owner element])

  The owner of an attribute is the element that possesses or contains the attribute.

The use of the term "document element" from **[XMLInfoSet]**, to describe the root of all elements in an XML document, is preferred over the informal and non-standard term "root element."

1.4.3. XML Schema Terminology

The terms “W3C XML Schema”, “XML Schema” (upper case “Schema”) and “XSD” all refer to the XML Schema specification, Parts 1 and 2 of the *W3C XML Schema Definition Language (XSD) Recommendations* (**[XMLSchemaStructures]** and **[XMLSchemaDatatypes]**).

The term “XML schema” (lower case “schema”) refers to specific XML schema documents that conform to the XML Schema specifications listed above.

The term “XML instance” refers to an XML instance document, which is defined by and validates to a particular XML schema.

The term "schema component" is defined in **[XMLSchemaStructures]** as a building block for XML Schema. This document refers to, rather than restates, the definitions to the different schema components associated with the XML Schema Abstract Data Model, which are defined in the XML Schema specification. In this document, the name of the referenced schema component may appear without the suffix “schema component” (i.e. the term “complex type definition” is used instead of “complex type definition schema component”), to enhance readability of the text.

The term “NCName” is defined in **[XMLSchemaDatatypes]**, and refers to XML “non-colonized” names, i.e., XML name strings that do not contain the “:” character.

1.4.4. XML Namespace Terminology

This document uses the concept of an “XML Namespaces” as defined by **[XMLNamespaces]** and **[XMLNamespacesErrata]**.

1.5. Document Organization

This remainder of this document is organized into sections as follows:

- The NIEM Conceptual Model discusses the underlying semantic model for NIEM.

- Guiding Principles discusses the principles which serve as the foundation and guidelines for the rules.
- Relation to Standards discusses the use of the key standards used in the development of NIEM.
- XML Schema Design Rules discusses the rules for using XML Schema constructs in NIEM-conformant schemas.
- Modeling Rules discusses the rules for additional structure and constraints needed to build NIEM-conformant schemas.
- XML Instance Rules discusses the rules for NIEM-conformant XML instance documents.
- Naming Rules discusses the rules used in naming NIEM-conformant data components.

NOTE: The ordering of the sections is intended to minimize the number of forward references in the document. For this reason, the naming rules appear as the last section of the document, so that the concepts being named have already been discussed.

This document also contains appendices of reference material as follows:

- A brief, non-normative overview of NIEM.
- A listing of all design principles, for reference purposes.
- A listing of all rules, for reference purposes.
- A table summarizing the NIEM names syntax for special NIEM components.
- Tables that appear in the body of this document, repeated for reference purposes.
- Discussion and full listings of the NIEM 2.0 supporting schemas (`structures` and `appinfo`).
- An itemized listing of the NIEM 2.0 reference schemas.
- A listing of high level design guidelines.
- A listing of modeling guidelines for harmonization.
- References to external standard documents.

A glossary of all the normative definitions found throughout this document, for reference purposes.

2. The NIEM Conceptual Model

The NIEM provides a concrete semantic model, leveraging concepts from XML Schema, RDF and the ISO/IEC Standard 11179 Metadata Registries. This semantic model underlies all NIEM-conformant schemas, as well as NIEM-conformant instance data. XML data that follows the rules of NIEM imply specific meaning. The XML Schema components used in NIEM are selected to clarify the meaning of XML data.

NIEM provides a framework, within which XML data may be understood to have specific meaning. In general, one limitation of XML is that it does not describe the meaning of an XML document. NIEM adds to the XML specification a guide to determining the meaning of any given document.

The goal of this section is to clarify the meaning of XML data conformant to NIEM, and to outline the implications of various modeling constructs in NIEM. The NIEM follows, at a high level, the RDF conceptual model **[RDFConcepts]**, as outlined in this section.

The rules for NIEM-conformant schemas and instances are in place to ensure that a specific meaning can be derived from data. That is, the data makes specific assertions, and those assertions are well-understood, since they are derived from the rules for NIEM.

The key concepts underpinning the NIEM Conceptual Model are discussed in the remainder of this section:

- NIEM Data Objects
- NIEM Data Assertions
- NIEM Data Model Explicit Not Implicit
- NIEM Data Model Implementation in XML Schema

2.1. NIEM Data Objects

In NIEM, an exchange is generally ad-hoc. That is, a message may be generated without any persistence. It exists only for the purpose of exchange, and may not have any universal meaning beyond the specific exchange. As such, a message may or may not have a URI as an identifier. NIEM was designed with the assumption that a given exchange may not have any unique identifier. This differs from RDF, in which all entities (other than literal values) are identified by globally-meaningful URIs.

In NIEM, an object (data instance) is assumed to not be identified by a URI. This differs from RDF, where each data object is identified by its URI. In NIEM, there is not necessarily a universal, unique identifier for any given data object.

A NIEM-conformant instance uses XML IDs to identify objects within an XML document, The NIEM XML ID is an attribute `structures:id`, of type `xsd:ID`. These IDs are not assumed by NIEM to have any universal significance; they need only be unique within the XML document. The use of an ID is required only when an object must be referenced within the document. NIEM recognizes no correlation between these local IDs and any URI.

Any given implementation, message, or IEPD may be defined to apply a URI or other universally-meaningful identifier to an object or message. However, NIEM has no such requirement.

Objects are instances of classes, in an object-oriented design sense. In RDF, such classes are described by types, which is also how NIEM refers to them. In RDF, a schema describes these classes. NIEM represents classes with type definition definitions: complex type definitions and simple type definitions.

Data describes characteristics of objects and relationships between objects. In RDF, these characteristics and relationships are called **properties** of objects, which is also how NIEM refers to them. NIEM represents properties with element declarations and attribute declarations.

Within data, an instance of a property has several characteristics. The terminology comes from RDF, and is similar to the words describing the relationship of a verb to nouns in a sentence: a verb has a subject and an object.

- The **property** itself: What relationship is being asserted? For example, the property may say that there are brothers, or that someone has hair of a particular color.
- The **subject**: About what object is the property being asserted? This would be the person that has the brother, or the person whose hair is being described.
- The **object**: What is the value of the property, or to what other object does the relationship exist? This would be the person that is the brother of the subject, or person whose hair has the color brown.

A property relates *two* objects. Data will describe an object having a characteristic with a specific value, or will describe an object with a particular relationship to another object. All properties are pair-wise: between two objects, or between an object and a value.

In theory, any relationship that involves more than two objects may be modeled as a set of binary properties. In NIEM, such relationships may be expressed either as a set of properties (i.e. as element and attribute declarations) or as a complex type definition.

2.2. NIEM Data Assertions

Data consists of **assertions** about objects. These assertions are categorized as follows:

- Assertions that **objects exist**

  Any reference to a data object asserts that the object exists. For example, XML data about a person says that the person exists.

- Assertions that **objects have characteristics**

  Any reference to some characteristic of the object. For example, XML data about a person with the name "John" asserts that a person has a characteristic called “name” and the characteristic has a value of “John.”

- Assertions that **objects participate in relationships**

  Any reference to relationship from one object to one or more objects. For example, XML data about a person may contain a characteristic which represents a “brother” relationship. The value of that characteristic refers to another object that is considered to be a person. The XML data associated with the person assert that there is a person, that the person is in a relationship with another person, and that these two people are brothers.

2.3. NIEM Data Model Explicit Not Implicit

In NIEM data, that which is not stated is not implied. If data says a person's name is "John", it is not implicitly saying that he doesn't have other names, or that “John” is his legal name, or that he is different from a person known as “Bob.” The only assertion being made is that one of the names by which this person is known is "John".

This is one reason that definitions of NIEM content are so important. The definitions must state exactly what is implied by any given statement. The concept of "legal name" may be defined that makes additional assertions about a name of a person. Such assertions must be made explicit in the definition of the relationship.

2.4. NIEM Data Model Implementation in XML Schema

NIEM defines rules for XML schemas which enforce the NIEM conceptual model. The schemas which follow these rules are referred to as **NIEM-conformant schemas**.

As discussed above, NIEM classes and properties are mapped onto XML Schema components. The following is an example of how a NIEM class for "Person" is rendered as an XML Schema complex type definition:

Conceptual class rendered as XML Schema complex type

```
<xsd:complexType name="PersonType">
  ...
</xsd:complexType>
```

The following is an example of how a NIEM property for "ImageOperator" is rendered as an element declaration:

Conceptual property rendered as element declaration

```
<xsd:element name="ImageOperator" type="nc:PersonType" nillable="true">
  ...
</xsd:element>
```

NIEM also defines rules for XML documents which enforce the NIEM conceptual model. XML data is called a **NIEM-conformant instance** if it follows the rules specified by the NIEM-conformant schema, as well as additional rules that are NIEM-specific. For example, in a NIEM-conformant instance, XML IDREFs must refer to XML IDs defined on objects of appropriate type. If this is not the case, the data may be valid according to the XML schema, but will not be NIEM-conformant.

Sample fragment of NIEM-conformant data

```
<nc:Person>
  <nc:PersonHairColorCode>BRN</nc:PersonHairColorCode>
</nc:Person>
```

Based on an element declaration from NIEM Core, the following example illustrates a valid XML instance that does not conform to NIEM. Per the `appinfo:ReferenceTarget` element in the schema declaration, `nc:ActivityReference` may ONLY refer to an `nc:ActivityType`. However, within the instance, `my:ActivityList/nc:ActivityReference` refers to "Bill", which is an `nc:PersonType`.

Schema declaration for element nc:`ActivityReference`

```
<xsd:element name="ActivityReference" type="structures:ReferenceType">
  <xsd:annotation>
    <xsd:documentation>
      A single or set of related actions, events, or process steps.
    </xsd:documentation>
    <xsd:appinfo>
      <appinfo:ReferenceTarget appinfo:name="ActivityType"/>
    </xsd:appinfo>
  </xsd:annotation>
</xsd:element
```

Valid instance for above schema that does NOT conform to NIEM rules

```
<nc:Person structures:id=”Bill”>
  <nc:PersonFullName>William Tell</nc:PersonFullName>
  <nc:PersonSexCode>M</nc:PersonSexCode>
</nc:Person>

<nc:Activity structures:id=”Pie”>
  <nc:ActivityDescriptionText>
    County fair pie-eating contest
  </nc:ActivityDescriptionText>
</nc:Activity>

<my:ActivityList>
  <nc:ActivityReference structures:ref=”Pie”/>
  <nc:ActivityReference structures:ref=”Bill”/>
</my:ActivityList>
```

3. Guiding Principles

Principles in this specification provide a foundation for the rules. These principles are generally applicable in most cases. They should not be used as a replacement for common sense or appropriate special cases.

The principles are not operationally enforceable; they do not specify constraints on XML schemas and instances. The rules are the normative and enforceable manifestation of the principles.

The principles discussed in this section are categorized as follows:

- Specification Guidelines
- XML Schema Design Guidelines
- Modeling Design Guidelines
- Implementation Guidelines

3.1. Specification Guidelines

The principles in this section address what material should be included in this NDR, and how it should be represented.

3.1.1. Keep Specification To Minimum

This specification should state what is required for interoperability, not all that could be specified. Certain decisions (such as normative XML comments) could create roadblocks for interoperability, making heavy demands on systems for very little gain. The goal is not standardization for standardization's sake. The goal is to maximize interoperability and reuse.

[Principle 1]

This specification should specify what is necessary for interoperability, and no more.

3.1.2. Focus On Rules For Schemas

This specification should try, as much as is possible, to specify schema-level content. This is a specification for schemas, and so should specify schemas. It should avoid specifying complex data models, or data dictionaries.

[Principle 2]

This specification should focus on providing rules for specifying schemas.

3.1.3. Use Specific Concise Rules

A rule should be as precise and specific as possible, to avoid broad, hard-to-modify rules. Putting multiple clauses in a rule makes it harder to enforce. Using separate rules allows specific conditions to be clearly stated.

[Principle 3]

This specification should feature rules which are as specific, precise, and concise as possible.

3.2. XML Schema Design Guidelines

The principles in this section address how XML Schema technology should be used in designing NIEM-conformant schemas and instances.

3.2.1. Disallow Content Modification with XML Processors

XML Schema has constructs that can make the data provided by XML processors different before and after schema processing. A sample of this is the use of XML Schema attribute declarations with default values. Before XML schema validation, there may be no attribute value, but after processing, the attribute value exists.

Within NIEM, the purpose of processing instances against schemas is solely validation: testing that data instances match desired constraints and guidelines. It should not be used to change the content of data instances.

[Principle 4]

> The content of a NIEM-conformant data instance should not be modified by processing against XML schemas.

3.2.2. Use XML Validating Parsers for Content Validation

NIEM is designed for XML Schema validation. A primary goal is to maximize the amount of validation that may be performed by XML Schema validating parsers.

XML Schema validates content using content models: descriptions of what elements and attributes may be contained within an element, and what values are allowable. Mechanisms involving linking using attribute and element values are useful, but should only be relied upon when absolutely necessary.

[Principle 5]

> NIEM should depend on XML Schema validating parsers for validation of XML content.

3.2.3. Validate for Conformance to Reference Schemas

Systems that operate on XML data have the opportunity to perform multiple layers of processing. Data may be processed by middleware, XML libraries, XML schemas, and application software.

[Principle 6]

> The primary purpose of XML Schema validation is to restrict processed data to that data that conforms to agreed-upon rules. This restriction is achieved by marking as invalid that data that does not conform to the rules defined by the schema.

3.2.4. Allow Multiple Schemas for XML Constraints

The NIEM does not attempt to create a one-size-fits-all schema, to perform all validation. Instead, it creates a set of reference schemas, on which additional constraints may be placed. It also does not focus on language-binding XML Schema implementations, which convert XML Schema definitions into working programs. It is, instead, focused on normalizing language and preserving the meaning of data.

[Principle 7]

> Constraints on XML instances MAY be validated by multiple schema validation passes, using multiple schemas for a single namespace.

3.2.5. Define One Reference Schema Per Namespace

NIEM uses the concept of a *reference schema*, which defines the structure and content of a namespace. For each NIEM-conformant namespace, there is exactly one NIEM reference schema. A user may use a NIEM subset schema in place of a NIEM reference schema, but all NIEM-conformant instances must validate against a single reference schema for each namespace.

[Principle 8]

Each NIEM-conformant namespace will be defined by exactly one reference schema.

3.2.6. Disallow Mixed Content

When validating XML instance data against XML schemas, mixed content is very difficult to constrain. Instances that use mixed content are difficult to specify, and complicate the task of data processing. Much of the payload carried by mixed content is unchecked, and does not facilitate data standardization or validation.

[Principle 9]

NIEM-conformant schemas do not specify data that uses mixed content.

3.2.7. Specify Types for All Constructs

Schema components within NIEM all have names. This means that there are no anonymous types, elements, or other components defined by NIEM. Once an application has determined the name (i.e. namespace and local name) of an attribute or element used in NIEM-conformant instances, it will also know the type of that attribute or element.

There are no local attributes or elements defined by NIEM, only global attributes and elements. This maximizes the ability of application developers to extend, restrict, or otherwise derive definitions of local components from NIEM-conformant components.

[Principle 10]

Using named global components in schemas maximizes the capacity for reuse.

3.2.8. Avoid Wildcards In Reference Schemas

Wildcards in NIEM-conformant schemas work in opposition to standardization. The goal of creating harmonized, standard schemas is to standardize definitions of data. The use of wildcard mechanisms (such as `xsd:any`, which allows insertion of an arbitrary number of elements from any namespace) allow non-standard data to be passed via otherwise standardized exchanges. Avoidance of wildcards encourages the separation of standardized and non-standardized data. It encourages users to incorporate their data into NIEM in a standardized way. It also encourages users to extend in a way that may be readily incorporated into NIEM.

[Principle 11]

Wildcards in standard schemas should be avoided.

3.2.9. Provide Default Reference Schema Locations

[XMLSchemaStructures] provides three ways to specify the physical location of an XML schema: `schemaLocation`, an attribute of the element `xsd:import,` along with `xsi:schemaLocation` and `xsi:noNamespaceSchemaLocation`, attributes of an XML schema document element. In all of these uses, the specification explicitly maintains that the schema location specified is a hint, which may be overridden by applications.

[Principle 12]

Schema locations specified within NIEM-conformant reference schemas are hints and provide default values to processing applications.

3.3. Modeling Design Guidelines

The principles in this section address the design philosophy used in designing the NIEM conceptual model.

3.3.1. Namespaces Enhance Reuse

NIEM is designed to maximize reuse of namespaces and the schemas that define them. When referring to a concept defined by NIEM, a user should ensure that instances and schemas refer to the namespace defined by NIEM. User-defined namespaces should be used for specializations and extension of NIEM constructs, but should not be used when the NIEM structures are sufficient.

[Principle 13]

> NIEM-conformant instances and schemas should reuse components from NIEM distribution schemas when possible.

NIEM relies heavily on XML namespaces to prevent naming conflicts and clashes. Reuse of any component is always by reference to both its namespace and its local name. All NIEM component names have global scope, therefore validation always occurs against the reference schemas or subsets thereof.

Example:

```
<xsd:element ref="nc:BinaryCaptureDate"
    minOccurs="0"
    maxOccurs="unbounded"/>
```

In this example, `nc:BinaryCaptureDate` is reused by referencing its element declaration through both its namespace (which is bound to the prefix `nc:`) and its local name (`BinaryCaptureDate`). If an element named `BinaryCaptureDate` is declared in another namespace, it is an entirely different element and is unrelated to `nc:BinaryCaptureDate`. There is no implicit relationship to `nc:BinaryCaptureDate`. Any relationship must be made explicit using methods outlined in this document.

[Principle 14]

> A namespace is a required part of the name of a component. A component's local name is considered independent of, and unassociated with, names from other namespaces.

3.3.2. Design NIEM for Extensibility

NIEM is designed to be extended. Numerous methods are considered acceptable in creating extended and specialized components.

[Principle 15]

> NIEM is intended for extension and augmentation by users and developers outside the standardization process.

3.4. Implementation Guidelines

The principles in this section address issues pertaining to the implementation of applications that use NIEM.

3.4.1. Avoid Displaying Raw XML Data

XML data should be made human-understandable when possible, but it is not targeted at human consumers. XML Schema is intended for validators and automatic processing. HTML is intended for browsers. Browsers and similar technology provide human interfaces to XML and other structured content. As such, structured XML content does not belong in places targeted towards human consumption. Human-targeted information should be of a form suitable for presentation.

[Principle 16]

> XML data is primarily intended for automatic processing, not for literal presentation to people.

3.4.2. Leave Implementation Decisions To Implementers

NIEM is intended to be an open specification, supported by many diverse implementations. It was designed from data requirements and not from or for any particular system or implementation. Use of NIEM should not depend on specific software, other than XML Schema validating parsers.

[Principle 17]

> NIEM should not depend on specific software packages, frameworks, or systems for interpretation of XML instances.

Similarly, the NIEM should be implemented with commercial off-the-shelf and free software products.

[Principle 18]

> NIEM should be implemented with a variety of commercial off-the-shelf and free software products.

3.4.3. Documentation

As will be described in later sections of this document, all NIEM components are documented through their definitions and names. Although it is often very difficult to apply, a data component definition should be drafted before the data component name is assigned.

Drafting the definition for a data component first, ensures that the author understands the exact nature of the entity or concept that the data component represents. The component name should subsequently be composed to summarize the definition. Reversing this sequence often results in data definitions that very precisely describe the component name, but do not adequately describe the entity or concept that the component is designed to represent. This potentially leads to the ambiguous use of such components.

[Principle 19]

> A data component definition should be drafted before the associated data element name is composed.

3.4.4. Consistent Naming

Components in NIEM should be given names which are consistent with names of other NIEM components. Having consistent names for components has several advantages:

1. It is easier to determine the nature of a component when it has a name that conveys the meaning and use of the component.
2. It is easier to find a component when it is named predictably.

3. It is easier to create a name for a component when clear guidelines exist.

[Principle 20]

Components in NIEM should be given names which are consistent with names of other NIEM components. Such names should be based on simple rules.

4. Relation to Standards

This section specifies the standards and specifications to which the NIEM conforms. Where NIEM differs from public standards, the rationale for those differences is discussed in this section. The complete list of standards and specifications referenced in this section appears in Appendix I, References.

4.1. XML 1.0

[Rule 4-1]

A NIEM-conformant schema MUST conform to XML as specified by **[XML]**.

Rationale

XML is a well-known, commonly used W3C Recommendation. It is supported by a large number of commercial and open source software tools. It is a simple, well-defined, semi-structured data format that is flexible enough to allow for easy extension. XML works with many other powerful associated technologies such as XSLT and XPath. Artifacts of NIEM conform to the most recent recommendation for XML.

4.2. XML Namespaces

[Rule 4-2]

A NIEM-conformant schema MUST conform to the specification for namespaces in XML, as defined by **[XMLNamespaces]** and **[XMLNamespacesErrata]**.

Rationale

NIEM is designed to facilitate cross-domain data exchanges and interoperability. The ultimate scope of NIEM is anticipated to be quite large. The primary purpose of namespaces is to avoid naming conflicts, which for NIEM could become quite common, since NIEM stakeholders and IEPD developers define and name many of their own data components independently. Therefore, in NIEM, XML namespaces are employed both to avoid name clashes and to provide a level of independence to participating domains.

4.3. XML Schema

[Rule 4-3]

A NIEM-conformant schema MUST conform to the W3C XML Schema Recommendations: XML Schema Part 1: Structures and XML Schema Part 2: Datatypes, as specified by **[XMLSchemaStructures]** and **[XMLSchemaDatatypes]**.

Rationale

XML Schema has become the generally accepted schema language, and is experiencing the most widespread adoption. Although other schema languages exist that offer their own advantages and disadvantages, the current approach is to base NIEM on XML Schema.

4.4. ISO 11179, Part 4

Good data definitions are fundamental to data interoperability. You cannot effectively exchange what you cannot understand. NIEM employs the guidance of **[ISO 11179 Part 4]** as a baseline for its data component definitions. All NIEM components are documented.

[Definition: documented component]

In a NIEM-conformant schema, a **documented component** is an XML Schema component that is required to have associated documentation. These schema components are required to have a textual definition for the component to be well-understood. Schemas that do not document their components accordingly are not NIEM-conformant.

[Definition: definition]

The **definition** of a documented component is the content of the occurrence of an element `xsd:documentation` that is an immediate child of the occurrence of an element `xsd:annotation`. That element `xsd:annotation` is itself an immediate child of the element that defines the component.

Example of definition of `MeasureMetadataType`

```
<xsd:complexType name="MeasureMetadataType">
  <xsd:annotation>
    <xsd:documentation>
      A data type for metadata about a measurement.
    </xsd:documentation>
    <xsd:appinfo>
      <appinfo:Base
          appinfo:namespace=http://niem.gov/niem/structures/2.0
          appinfo:name="MetadataType"/>
      <appinfo:AppliesTo appinfo:name="MeasureType"/>
    </xsd:appinfo>
  </xsd:annotation>
  <xsd:complexContent>
    <xsd:extension base="s:MetadataType">
      <xsd:sequence>
        <xsd:element ref="nc:MeasureDate"
            minOccurs="0" maxOccurs="unbounded"/>
        <xsd:element ref="nc:Measurer"
            minOccurs="0" maxOccurs="unbounded"/>
      </xsd:sequence>
    </xsd:extension>
  </xsd:complexContent>
</xsd:complexType>
```

[Rule 4-4]

Within a NIEM-conformant schema, the text definition provided for each documented component SHALL follow the requirements and recommendations for data definitions given by **[ISO 11179 Part 4]**.

Rationale

To advance the goal of creating semantically-rich NIEM-conformant schemas, it is necessary that data definitions be descriptive, meaningful, and precise. **[ISO 11179 Part 4]** provides standard structure and rules for defining data definitions. The NIEM uses this standard for component definitions.

Note that the metadata maintained for each NIEM component contains additional details, including domain-specific usage examples and keywords. Such metadata is used to enhance search and discovery of components in a registry, and therefore, is not included in schemas.

For convenience and reference, the summary requirements and recommendations in **[ISO 11179 Part 4]** are reproduced here:

ISO 11179 Requirements

A data definition SHALL:

- be stated in the singular.
- state what the concept is, not only what it is not.
- be stated as a descriptive phrase or sentence(s).
- contain only commonly understood abbreviations.
- be expressed without embedding definitions of other data or underlying concepts.

ISO 11179 Recommendations

A data definition SHOULD:

- state the essential meaning of the concept.
- be precise and unambiguous.
- be concise.
- be able to stand alone.
- be expressed without embedding rationale, functional usage, or procedural information.
- avoid circular reasoning.
- use the same terminology and consistent logical structure for related definitions.
- be appropriate for the type of metadata item being defined.

In addition to the requirements and recommendations of **[ISO 11179 Part 4]**, NIEM also applies additional rules to data definitions. These rules are detailed in Section 6.2.1, Human-Readable Documentation.

4.5. ISO 11179, Part 5

Names are a simple but incomplete means of providing semantics to data components. Data definitions, structure, and context help to fill the gap left by the limitations of naming. The goals for data component names should be syntactic consistency, semantic precision, and simplicity. In many cases, these goals conflict and it is sometimes necessary to compromise or to allow exceptions to ensure clarity and understanding. To the extent possible, NIEM applies **[ISO 11179 Part 5]** to construct NIEM data component names.

The set of NIEM data components is a collection of data representations for real world objects, concepts, their associated properties and relationships. Thus, names for these components would consist of the terms (words) for object classes or that describe object classes, their characteristic properties, subparts, and relationships.

[Rule 4-5]

> In general, a NIEM component name SHALL be formed by applying the informative guidelines and examples detailed in Annex A of **[ISO 11179 Part 5]**, with exceptions as specified in this document, most notably those specified in Section 8, Naming Rules.

Rationale

> The guidelines and examples of **[ISO 11179 Part 5]** provide a simple, consistent syntax for data names which captures context and thereby imparts a reasonable degree of semantic precision.

NIEM uses the guidelines and examples of **[ISO 11179 Part 5]** as a baseline for normative naming rules. However, some NIEM components require bending of these rules. Special naming rules for these classes of components are presented and discussed in Section 8. In spite of these exceptions, most NIEM component names can be disassembled into their **[ISO 11179 Part 5]** constituent words or terms.

Example:

The NIEM component name `AircraftFuselageColorCode` disassembles as follows:

- Object class term = “`Aircraft`”
- Qualifier term = “`Fuselage`”
- Property term = “`Color`”
- Representation term = “`Code`”

Section 8, Naming Rules details the specific rules for each kind of term and how to construct NIEM component names from them. Exceptions for special components are also described in Section 8.

5. XML Schema Design Rules

The W3C XML Schema Language provides many features that allow a developer to represent a logical data model many different ways. This section establishes rules for the use of XML Schema constructs within NIEM-conformant schemas. Because the XML Schema specifications are flexible, comprehensive rules are needed to achieve a balance between establishing uniform schema design and providing developers flexibility to solve novel data modeling problems

Note that external schemas (non NIEM-conformant schemas) do not need to obey the rules set forth in this section. So long as schema components from external schemas are adapted for use with NIEM, according to the modeling rules in Section, , they may be used as they appear in the external standard, even if the schema components violate the rules for NIEM-conformant schemas.

The XML Schema design rules in this section fall into the following categories:

- Restrictions on XML Schema Constructs
- `xsd:schema` Document Element
- Namespace Imports
- Annotations
- Type Definitions
- Additional De

5.1. Restrictions on XML Schema Constructs

There are a number of XML Schema constructs that are not used within NIEM-conformant schemas. Many of these constructs provide capability that is not currently needed within NIEM. Some of these constructs create problems for interoperability, or with tool support, or with clarity or precision of data model definition.

5.1.1. No Mixed Content

[Rule 5-1]

> Within a NIEM-conformant schema, an element `xsd:complexType` SHALL NOT own the attribute mixed with the value true.

[Rule 5-2]

> Within a NIEM-conformant schema, an element declaration which is of complex content SHALL NOT own the attribute `mixed` with the value `true`.

Rationale

> Mixed content allows the mixing of data tags with text. Languages such as XHTML use this syntax for markup of text. NIEM-conformant schemas define XML that is for data exchange, not text markup. Mixed content creates complexity in processing, defining, and constraining content.
>
> Well-defined markup languages exist outside of NIEM, and may be used with NIEM data. External schemas may include mixed content, and may be used with NIEM. However, mixed content must not be defined by NIEM-conformant schemas in keeping with **[Principle 9]**.

5.1.2. No Notations

[Rule 5-3]

A NIEM-conformant schema SHALL NOT contain a reference to the type definition `xsd:NOTATION`, or to a type derived from that type.

[Rule 5-4]

A NIEM-conformant schema SHALL NOT contain the element `xsd:notation`.

Rationale

XML Schema notations allow the attachment of system and public identifiers on fields of data. The notation mechanism does not play a part in validation of instances and is not supported by NIEM.

5.1.3. No Schema Inclusion

[Rule 5-5]

A NIEM-conformant schema SHALL NOT contain the element `xsd:include`.

Rationale

Element `xsd:include` brings schemas defined in separate files into the current namespace. It breaks a namespace up into arbitrary partial schemas, which needlessly complicates the schema structure, making it harder to reuse, and process, and also increases the likelihood of conflicting definitions.

Inclusion of schemas that don't have namespaces also complicates schema understanding. This inclusion makes it difficult to find the realization of a specific schema artifact, and creating aliases for schema components that should be reused. Inclusion of schemas also violates **[Principle 8]**, as it uses multiple schemas to construct a namespace.

5.1.4. No Schema Redefinition

[Rule 5-6]

A NIEM-conformant schema SHALL NOT contain the element `xsd:redefine`.

Rationale

The `xsd:redefine` element allows an XML schema to restrict and extend components from a namespace, in that very namespace. Such redefinition introduces duplication of definitions, allowing multiple definitions to exist for components from a single namespace. This violates **[Principle 8]** that a single reference schema defines a NIEM-conformant namespace.

5.1.5. Wildcard Restrictions

There are many constructs within XML Schema that act as wildcards. That is, they introduce buckets which may carry arbitrary or otherwise non-validated content. Such constructs violate **[Principle 11]**, and as such provide implicit workarounds for the difficult task of agreeing on the content of data models. Such workarounds should be made explicitly, outside the core data model.

5.1.5.1. No Unconstrained Type Substitution

[Rule 5-7]

A NIEM-conformant schema SHALL NOT reference the type `xsd:anyType`.

Rationale

XML Schema has the concept of the "ur-type", a type that is the root of all other types. This type is realized in schemas as `xsd:anyType`.

NIEM-conformant schemas must not use `xsd:anyType`, because this feature permits the introduction of arbitrary content (i.e. untyped and unconstrained data) into an XML instance. NIEM intends that all constructs within the instance be described by the schemas describing that instance.

5.1.5.2. No Unconstrained Text Substitution

[Rule 5-8]

A NIEM-conformant schema SHALL NOT reference the type `xsd:anySimpleType`.

Rationale

XML Schema provides a restriction of the “ur-type”, which contains only simple content. This provides a wildcard for arbitrary text. It is realized in XML Schema as `xsd:anySimpleType`.

NIEM-conformant schemas must not use `xsd:anySimpleType` because this feature is insufficiently constrained to provide a meaningful starting point for content definitions. Instead, content should be based on one of the more specifically-defined simple types defined by XML Schema.

5.1.5.3. Untyped Elements Must be Abstract

[Rule 5-9]

Within a NIEM-conformant schema, an element declaration with the attribute `name` and without the attribute `type` MUST carry the attribute `abstract` with the value `true`.

Rationale

Untyped element declarations act as wildcards that may carry arbitrary data. By declaring such types abstract, NIEM allows the creation of type independent semantics without allowing arbitrary content to appear in XML instances.

5.1.5.4. No Untyped Attributes

[Rule 5-10]

Within a NIEM-conformant schema, an attribute declaration with attribute `name` MUST carry the attribute `type`.

Rationale

Untyped XML schema attributes allow arbitrary content, with no semantics. Attributes must have a type, so that specific syntax and semantics will be provided.

5.1.5.5. No Unconstrained Element Substitution

[Rule 5-11]

A NIEM-conformant schema SHALL NOT contain the element `xsd:any`.

Rationale

The `xsd:any` particle (see Model Group Restrictions for an informative definition of particle) provides a wildcard which may carry arbitrary content. The particle `xsd:any` may appear within constraint schemas or within other schemas that are not NIEM-conformant, but is prohibited in NIEM-conformant schemas.

5.1.5.6. No Unconstrained Attribute Substitution

[Rule 5-12]

A NIEM-conformant schema SHALL NOT contain the element `xsd:anyAttribute`.

Rationale

The `xsd:anyAttribute` element provides a wildcard, where arbitrary attributes may appear. The element `xsd:anyAttribute` may appear within constraint schemas or within other schemas that are not NIEM-conformant, but is prohibited in NIEM-conformant schemas.

5.1.6. Component Naming Restrictions

All NIEM components must be named. That is, type definitions, and element and attribute declarations must be given explicit names -- local and anonymous component definition is not allowed. Note that XML Schema enforces the placement of attribute group and model group definitions as top-level components, which forces the components to be named.

5.1.6.1. No Anonymous Type Definitions

[Rule 5-13]

Within a NIEM-conformant schema, any type definition MUST appear as an immediate child of the document element `xsd:schema`.

Rationale

NIEM does not support anonymous types in NIEM-conformant schemas. All XML Schema "top-level" types (children of the document element) are required by XML Schema to be named. By requiring NIEM type definitions to be top level, they are forced to be named and are therefore globally reusable.

5.1.6.2. No Local Element Declarations

[Rule 5-14]

Within a NIEM-conformant schema, any element declaration carrying the attribute `name` MUST appear as an immediate child of the document element `xsd:schema`.

Rationale

All schema components defined by NIEM schemas must be named, accessible from outside the defining schema, and reusable across schemas. Local element definitions provide named elements that are not reusable outside the context in which they are defined. Requiring named NIEM elements to be top level ensures that they are globally reusable.

5.1.6.3. No Local Attribute Definitions

[Rule 5-15]

Within a NIEM-conformant schema, any attribute declaration owning the attribute `name` MUST appear as an immediate child of the document element `xsd:schema`.

Rationale

All schema components defined by NIEM schemas are named, accessible from outside the defining schema, and reusable across schemas. Local attribute definitions provide named attributes that are not reusable outside the context in which they are defined. Requiring named NIEM attributes to be top level ensures that they are globally reusable.

5.1.7. No Uniqueness Constraints

[Rule 5-16]

A NIEM-conformant schema SHALL NOT contain any of the elements `xsd:unique`, `xsd:key`, `xsd:keyref`, `xsd:selector`, or `xsd:field`.

Rationale

XML Schema provides NIEM the ability to apply uniqueness constraints to schema-validated content. Such mechanisms have value, but they have not been included as required for NIEM. However, these elements may be used in subset or constraint schemas.

5.1.8. Model Group Restrictions

Complex content definitions in XML Schema use model group schema components. These schema components, `xsd:all, xsd:choice` and `xsd:sequence,` also called compositors, provide for ordering and selection of particles within a model group.

XML Schema defines a **particle** as an occurrence of `xsd:element`, `xsd:sequence`, `xsd:choice`, `xsd:any` (wildcard) and `xsd:group` (model group) within a content model. For example, an `xsd:sequence` within a XML Schema complex type is a particle. An `xsd:element` occurring within an `xsd:sequence` is also a particle.

5.1.8.1. Restrictions on Particle Ordering

[Rule 5-17]

A NIEM-conformant schema SHALL NOT contain the element `xsd:all` or the element `xsd:choice`.

Rationale

The element `xsd:all` provides a set of particles (e.g. elements) which may be included in an instance, in no particular order. The element `xsd:choice` provides an exclusive set of particles, one of which may appear in an instance. Each of these can greatly complicate processing and may provide complex regular expressions which are difficult to comprehend and satisfy. The only particle ordering mechanism allowed for use within NIEM-conformant schemas is `xsd:sequence`

5.1.8.2. No Recursively Defined Model Groups

[Rule 5-18]

Within a NIEM-conformant schema, any immediate child of a model group `xsd:sequence` element MUST be one of `xsd:annotation`, or `xsd:element.`

Rationale

XML Schema provides the capability for model groups to be recursively defined. This means that a sequence may contain a sequence. This rule is designed to keep content models simple, comprehensive and reusable: The content of an element should boil down to a sequence of elements, defined in as straightforward a manner as is possible.

5.1.8.3. Restrictions on Named Groups

[Rule 5-19]

A NIEM-conformant schema SHALL NOT contain the element `xsd:group`.

Rationale

NIEM does not allow groups of elements to be named other than as named complex types.

5.1.8.4. Particle Cardinality Restrictions

[Rule 5-20]

Within a NIEM-conformant schema, if the element `xsd:sequence` carries the attribute `minOccurs`, it MUST set the value for the attribute to `1`.

[Rule 5-21]

Within a NIEM-conformant schema, if the element `xsd:sequence` carries the attribute `maxOccurs`, it MUST set the value of the attribute to `1`.

Rationale

XML Schema allows each particle to specify cardinality (how many times the particle may appear in an instance). NIEM restricts the cardinality of `xsd:sequence` and `xsd:group` particles to exactly one, to ensure that content model definitions are defined in as straightforward a manner as possible.

Discussion

Note that the particle `xsd:any` is not allowed in NIEM-conformant schema by **[Rule 5-11]**

Note also that element declarations acting as a particle (particles formed by `xsd:element`) may have any cardinality; they are not restricted by this rule. Should a user desire the behavior that would be obtained from the use of special cardinalities on these particles, he should define them within explicitly-named elements.

5.1.9. Block Substitution Restrictions

XML Schema provides a mechanism that will prevent substitution for an element declaration or type definition. That is, an element declaration may declare one or more of the following:

1. An instance of this element declaration may not substitute an extended type
2. An instance of this element declaration may not substitute a restricted type
3. An instance of this element declaration may not substitute another element

These restriction mechanisms are very useful in instances; they allow restriction of content models down to exact types and elements. However, in shared data models, they limit reuse and customization options, in opposition to **[Principle 13]**.

[Rule 5-22]

Within a NIEM-conformant schema, if an element declaration carries the attribute `block`, it MUST set the value for the attribute to the empty string.

[Rule 5-23]

> Within a NIEM-conformant schema, if a complex type definition carries the attribute `block,` it MUST set the value for the attribute to the empty string.

[Rule 5-24]

> Within a NIEM-conformant schema, if the document element `xsd:schema` carries the attribute `blockDefault`, it MUST set the value for the attribute to the empty string.

Rationale

> Restriction of substitution options reduces capacity for reuse, and so is forbidden within NIEM-conformant schemas   In particular, setting the `block` value at the schema level complicates understanding of component definitions.

5.1.10. Final Value Restrictions

XML Schema provides the capability for type definitions and elements to declare a **final** value. This value prevents the creation of derived components. In shared data models, this capability limits reuse and customization options. in opposition to **[Principle 13]**

[Rule 5-25]

> Within a NIEM-conformant schema, if a simple type definition carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-26]

> Within a NIEM-conformant schema, if a complex type definition carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-27]

> Within a NIEM-conformant schema, if an element declaration carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-28]

> Within a NIEM-conformant schema, if the document element `xsd:schema` carries the attribute `finalDefault`, it MUST set the value for that attribute to the empty string.

Rationale

> Restriction of derivation options reduces capacity for reuse and so is forbidden within NIEM-conformant schemas.

5.1.11. Default Value Restrictions

XML Schema provides the capability for element and attribute declarations to provide default values when XML instances using those components do not provide values.

[Rule 5-29]

> Within a NIEM-conformant schema, any element `xsd:element` SHALL NOT carry the attribute `default`.

[Rule 5-30]

> Within a NIEM-conformant schema, any element `xsd:attribute` SHALL NOT carry the attribute `default`.

Rationale

The use of default values means that the act of validating a schema will insert a value into an XML instance where none existed prior to schema validation. Schema validation is for rejection of invalid instances, not for modifying instance content, as specified in **[Principle 4]**.

5.1.12. Simple Type Derivation Restrictions

XML Schema provides two methods for combining simple types together into more complicated simple types: NIEM explicitly disallows the use of both these methods.

5.1.12.1. No Lists of Simple Type

An `xsd:list` creates a new simple type that consists of multiple occurrences of the original type, separated by whitespaces. An example of a list of `xsd:integer` is "`317 4 36 114`."

[Rule 5-31]

A NIEM-conformant schema SHALL NOT contain the element `xsd:list`.

Rationale

Such structured sequences of simple values should be represented with sequences of elements, rather than embedding the values in a single value.

5.1.12.2. No Unions of Simple Type

An `xsd:union` of several simple types creates a new simple type that may consist of the content of any of the member types. An example of a union is a union between `xsd:integer` and `xsd:anyURI` would produce a simple type that may contain a URI or integer value.

[Rule 5-32]

A NIEM-conformant schema SHALL NOT contain the element `xsd:union.`

Rationale

`xsd:union` loses the original semantic information associated with the member types. Providing such options should be done at the element level, rather than within the definitions of simple type.

5.2. `xsd:schema` Document Element

The features of XML Schema allow for flexibility of use for many different and varied types of implementation. NIEM requires consistent use of these features.

[Rule 5-33]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST carry the attribute `targetNamespace`.

[Rule 5-34]

The value of the required attribute `targetNamespace` on the document element `xsd:schema` MUST match the production `<absolute-URI>` as defined by **[RFC3986]**.

Rationale

Schemas without defined namespaces provide definitions that are ambiguous, in that they are not universally identifiable.

Absolute URIs are the only universally meaningful URIs. Finding the target namespace using standard XML Base technology is complicated, and not specified by XML Schema. Relative URIs are not universally identifiable, as they are context-specific.

Discussion

The document element `xsd:schema` may contain optional attributes `attributeFormDefault` and `elementFormDefault`. The values of these attributes are immaterial to a NIEM-conformant schema, as each attribute defined by a NIEM-conformant schema must be defined at the top-level, and so must be qualified with the target namespace of its declaration.

[Rule 5-35]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST carry the attribute `version`.

[Rule 5-36]

The value of the required attribute `version` on the document element `xsd:schema` MUST NOT be an empty string.

Rationale

It is very useful to be able to tell one version of a schema from another. Apart from the use of namespaces for versioning, it is sometimes necessary to release multiple versions of schema documents. Such use might include:

- Subset schemas
- Error corrections or bug-fixes
- Documentation changes
- Contact information updates

In such cases, a different value for the `version` attribute implies a different version of the schema. No specific meaning is assigned to specific version identifiers.

5.3. Namespace Imports

XML Schema requires that namespaces used in external references be imported using the `xsd:import` element. The `xsd:import` element appears as an immediate child of the `xsd:schema` element. A schema must import any namespace which

1. is not the local namespace, and
2. is referenced from the schema.

The behavior of import statements is not necessarily intuitive. In short, the import introduces namespace into the schema in which the import appears; it has no transitive effect. If the namespaces of an import statement is not referenced from the schema, then the import statement has no effect. The import statement cannot be used to direct schema locations for schemas not referenced from the schema performing the import. The schema location directed by the import element may be overridden by user directive at the parser, or by being overridden by import elements from other schemas.

Imports of namespaces should be made as uniform as possible; all schemas in a schema set should agree on what schema location goes with a particular namespace. Otherwise, behavior may be dependent on the behavior of the parser, and the order of components in instance documents.

5.3.1. `xsd:import` Element Restrictions

[Rule 5-37]

Within a NIEM-conformant schema, the element `xsd:import` MUST carry the attribute `namespace`.

[Rule 5-38]

The value of the required attribute `namespace` carried by the element `xsd:import` MUST match the production `<absolute-URI>` as defined by **[RFC3986]**.

Rationale

An import that does not specify a namespace is enabling reference to non-namespaced components. NIEM requires that all components have a defined namespace. It is important that the namespace declared by a schema be universally defined and unambiguous. Use of the standard XML Base for processing is not specified by XML Schema, and so is not supported here.

[Rule 5-39]

Within a NIEM-conformant schema, the element `xsd:import` MUST carry the attribute `schemaLocation`.

Rationale

An import that does not specify a schema location gives no clue to processing applications as to where to find an implementation of the namespace. Even though such a provided schema location may be overridden, it is important that an initial default be provided for processing.

[Rule 5-41]

Within a NIEM-conformant schema, the value of the required attribute `schemaLocation` carried by the element `xsd:import` MUST match either the production `<absolute-URI>,` or the definition of "*relative-path reference*", as defined by **[RFC3986]**.

Rationale

The default value may be specified either as absolute or relative URIs. Since URNs are not resolvable, they are inappropriate for use in `schemaLocation`. The requirement for conformance to "*relative-path reference*" is required to avoid the more obscure syntax of "*network-path reference*" and the system-specific "*absolute-path reference*".

[Rule 5-42]

Within a NIEM-conformant schema, the value of the required attribute `schemaLocation` carried by the element `xsd:import` MUST be resolvable to a XML schema document file that is valid according to **[XMLSchemaStructures]** and **[XMLSchemaDatatypes]**.

Rationale

The XML Schema specification requires that the object imported via `xsd:import` must be a schema document. This rule reinforces that requirement.

Discussion

Note that relative URI references are dereferenced from the location of the schema document performing the import, not from the location of an instance or other schema. Although NIEM distribution schemas use only relative URI references, that need not be the case for other NIEM-conformant schemas.

5.3.2. Including XML Content from Other Namespaces

Within an XML schema, there are several mechanisms to include XML content that is not from the XML or XML Schema namespaces. Those mechanisms are:

1. Carrying attributes from other than the XML or XML Schema namespaces on an element in the XML Schema namespace.

   By the rules of XML Schema, any element may have attributes that are from other namespaces. These attributes do not participate in validation, but may carry information useful to tools which process schemas.

2. Adding content to the elements `xsd:appinfo` and `xsd:documentation`.

   XML Schema allows arbitrary XML content to be included within annotations. Such XML does not participate in validation, but may communicate useful information to schema readers or processors.

NIEM requires all such XML content to be “schema-valid.” That is, it must have a schema, and it must validate against that schema. The schemas must be introduced via `xsd:import` elements within the schema in which the content is used. This is for two reasons:

1. Some tools require imports of namespaces used within schemas, and validate against those schemas.
2. The definition and the validity of content within schemas should be clear.

[Rule 5-43]

Within a NIEM-conformant schema, when a namespace other than the XML namespace or the XML Schema namespace is used, it MUST be imported into the schema using the `xsd:import` element.

Rationale

This rule ensures that used namespaces have recognizable defining sources, and that they will cooperate with existing tools.

[Rule 5-44]

Within a NIEM-conformant schema, when a namespace other than the XML namespace or the XML Schema namespace is used, its content MUST be valid with respect to the schema imported for that namespace.

Rationale

XML Schema does not address the schema-validity of content used for annotations or attributes on schema components. This rule ensures that content used in such a manner is schema-valid. This encourages interoperable data definitions and schema documents.

5.4. Annotations

Annotations in XML Schema "provide for human- and machine-targeted annotations of schema components."[1] The two types: human-targeted and machine-targeted, are kept separate by the use of two separate container elements defined by XML Schema: `xsd:documentation` and `xsd:appinfo`.

[Rule 5-45]

Within a NIEM-conformant schema, an element SHALL have at most one instance of an element `xsd:annotation` as an immediate child.

Rationale

XML Schema allows annotations to be added to components in a fairly loose manner: there may be multiple annotations, each of which may have multiple `documentation` or `appinfo` elements. This flexibility in the syntax provides no additional expressivity, but does complicate processing, and so is forbidden in NIEM.

5.4.1. Human-Readable Documentation

XML Schema describes the content of `xsd:documentation` elements as "user information". This information is targeted for reading by humans. The XML Schema specification does not say what form human-targeted information should take. Within NIEM, user information is plain text, with no formatting or XML structure.

[Rule 5-46]

Within a NIEM-conformant schema, the content of an `xsd:documentation` element MUST be character information items as specified by **[XMLInfoSet]**.

Rationale

According to the XML Schema specification, the content of `xsd:documentation` elements is intended for human consumption, whereas other structured XML content is intended for machine consumption. Therefore, the `xsd:documentation` element MUST NOT contain structured XML data. As such, any XML content appearing within a documentation element is in the context of human-targeted examples, and should be escaped using `&lt;` and `&gt;`. This rule also prohibits comments within documentation elements.

See **[SchemaForXMLSchema]**, the schema for XML Schema, as an example of documentation elements containing properly escaped XML elements.

[Rule 5-47]

Within a NIEM-conformant schema, the element `xsd:annotation` MUST have at most one instance of the element `xsd:documentation` as an immediate child.

Rationale

NIEM-conformant schemas apply specific meaning to `xsd:documentation` elements: they provide definitions for components. In this context, multiple documentation elements obscure understanding.

[1] From `http://www.w3.org/TR/2004/REC-xmlschema-1-20041028/#element-annotation`

XML comments are not schema constructs and are not specifically associated with any schema-based components. As such, comments are not considered semantically meaningful by NIEM, and may not be retained through processing of NIEM schemas.

[Rule 5-48]

XML comments SHALL not be used for persistent information about constructs within XML Schemas.

Rationale

Since XML comments are not associated with any specific XML Schema construct, there is no standard way to interpret comments. As such, comments should be reserved for internal use, and XML Schema annotations should be preferred for meaningful information about components. NIEM specifically defines how information should be encapsulated in NIEM-conformant schemas via `xsd:annotation` elements.

5.4.2. Machine-Readable Annotations

XML Schema provides special annotations for support of automatic processing. The XML Schema specification provides the element `xsd:appinfo` to carry such content, and does not specify what style of content they should carry. In NIEM, `xsd:appinfo` elements carry structured XML content.

[Rule 5-49]

Within a NIEM-conformant schema, any immediate child of an `xsd:appinfo` element SHALL be an element information item, or a comment information item.

Rationale

Application information elements are intended for "automatic processing", and so should contain machine-oriented data, XML.

[Rule 5-50]

Within a NIEM-conformant schema, any element that is an immediate child of an `xsd:appinfo` element SHALL be in a namespace.

Rationale

Use of default namespace is allowed, but content has to have a real namespace, and namespaces must be declared. The XML namespaces specification includes the concept of content not in a namespace. Non-namespaced data runs counter to the principle of distinctly identifiable data definitions.

[Rule 5-50.1]

Within a NIEM-conformant schema, an element in the XML Schema namespace MUST NOT occur as a descendant of any element `xsd:appinfo`.

Rationale

NIEM-conformant schemas are designed to be very easily processed. Although uses of XML Schema elements as content of `xsd:appinfo` elements could be contrived, it is not current practice, and could seriously complicate the authoring of schema validators and processors, such as XSLT, which may evaluate XML elements by their namespace and name. Forbidding the use of XML Schema elements outside valid uses of schema will simplify such processing.

5.5. Type Definitions

XML Schema provides a variety of ways to define new types. This section covers first the NIEM restrictions on defining simple types and then on defining complex types, with both simple and complex content.

5.5.1. Simple Type Definitions

According to XML Schema, there are many ways to construct simple types. Within NIEM, the options are narrowed, in order to direct designs into fewer, better-defined patterns.

[Rule 5-51]

> Within NIEM-conformant schemas, the element `xsd:simpleType` MUST have the element `xsd:restriction` as an immediate child.

Rationale

> Any simple type must be a restriction of another type. The rules in Section 5.1.12, Simple Type Derivation Restrictions, eliminate the use of `xsd:list` and `xsd:union` in simple type derivations. Therefore, only `xsd:restriction` may be used to make new simple types.

5.5.2. Complex Type Definitions

XML Schema provides a large amount of flexibility in the creation of complex types. NIEM narrows down the schema capability to a smaller set of constructs.

Note that rules on prohibited constructs (Section 5.1.6.1: No Anonymous Type Definitions, above) forbid defining complex types as local types. All complex type definitions must be top-level, named components.

XML Schema makes a distinction between complex types with simple content versus complex types with complex content. Complex types with simple content (CSCs) have content which is not allowed to contain XML elements. Complex types with complex content (CCCs) have content which does contain XML elements. Since mixed content is prohibited in NIEM by **[Rule 5-1]**, all NIEM-conformant complex types are either CSCs or CCCs.

[Rule 5-52]

> Within a NIEM-conformant schema, the element `xsd:complexType` MUST have as an immediate child either the element `xsd:complexContent` or the element `xsd:simpleContent`.

Rationale

> XML Schema provides shorthand to defining complex content of a complex type, which is to define the complex type with immediate children which specify elements, or other groups, and attributes. In the desire to normalize schema representation of types, and to be explicit, NIEM forbids the use of that shorthand.

5.5.3. Simple Content (CSC) Restrictions

Within a NIEM-conformant schema, a CSC can be created one of two ways:

1. By extension of an existing CSC, or
2. By extension of an existing simple type.

Both of these methods use the element `xsd:extension`.

[Rule 5-53]

Within a NIEM-conformant schema, the element `xsd:simpleContent` MUST have as an immediate child the element `xsd:extension`.

Rationale

This rule ensures that the definition of a CSC will use the XML Schema extension facility. This allows for the above cases, while disallowing much more complicated syntactic options available in XML Schema.

Although the two above methods have similar syntax, there are subtle differences. NIEM's conformance rules ensure that any complex type has the necessary attributes for representing IDs, metadata, and link metadata. So, case 1 does not require adding these attributes, as they are guaranteed to occur in the base type.

However, in case 2, in which a new complex type is created from a simple type, the attributes for complex types must be added. This is done by reference to the attribute group `structures:SimpleObjectAttributeGroup`:

[Rule 5-54]

Within a NIEM-conformant schema, given an element `xsd:simpleContent` with a child `xsd:extension` owning an attribute `base`, if the attribute `base` has a value that resolves to the name of a simple type, then the element `xsd:extension` MUST have an immediate child element `xsd:attributeGroup`.

[Rationale]

This rule ensures that a CSC that is created as an immediate extension of a simple type adds the attributes required for specific NIEM linking mechanisms. This creates a pattern for CSC definition as follows:

Example of CSC derived from a simple type

```
<xsd:complexType name="PercentageType">
  ...
  <xsd:simpleContent>
    <xsd:extension base="nc:PercentageSimpleType">
      <xsd:attributeGroup ref="structures:SimpleObjectAttributeGroup"/>
    </xsd:extension>
  </xsd:simpleContent>
</xsd:complexType>
```

5.5.4. Complex Content (CCC) Restrictions

Within a NIEM-conformant schema, a CCC can be created one of two ways:

1. By extension of an existing complex type (CCC or CSC), or
2. By extension of the type `structure:ComplexObjectType`

Both of these methods use the element `xsd:extension`.

[Rule 5-55]

Within a NIEM-conformant schema, the element `xsd:complexContent` MUST have as an immediate child the element `xsd:extension`.

Rationale

NIEM does not support, as conformant, the use of complex type restriction. NIEM defines a language, in which specific content is allowed. It does not specify messages which forbid content. Such restrictions may be performed in non-conformant schemas, or within constraint schemas or other artifacts of constraint.

Note that use of the attribute `base` on `xsd:extension` is required by XML Schema.

The `xsd:extension` element says that the type under definition is an extension of another type. That type must be limited to those used with NIEM.

[Rule 5-56]

Within a NIEM-conformant schema, given an element `xsd:complexContent` with a child `xsd:extension` owning an attribute `base`, the attribute `base` MUST have a value that resolves to the name of one of

1. the type `structures:ComplexObjectType`, or
2. the type `structures:MetadataType`, or
3. the type `structures:AugmentationType`, or
4. a NIEM-conformant complex type.

[Rationale]

This rule ensures that a CCC has well-defined ancestry. In turn, this ensures that every CCC has well-defined semantics.

5.6. Additional Definitions And Declarations

XML Schema provides a variety of ways to declare and define elements and attributes.

5.6.1. Element Declarations

Within NIEM-conformant schemas, elements may be declared as abstract. Element declarations must be at the top-level, as rules in other sections prohibit the use of local elements. Elements may be defined without a type, but any element declaration that has no type must be declared abstract by **[Rule 5-9]**, which forbids anonymous type definitions.

Within an element declaration, the attributes `fixed`, `nillable`, and `substitutionGroup` may be used as per the XML Schema specification. The attribute `form` is irrelevant to NIEM, as NIEM-conformant schemas may not contain local element definitions by **[Rule 5-14]**.

Element uses (element declarations acting as particles) must reference top-level named elements. In an element use, NIEM allows any values for the XML Schema properties “max occurs” and “min occurs”.

Based on a variety of user requirements, all elements in the NIEM 2.0 schemas are defined to allow a nil value. For example, the following XML instances are permitted in NIEM-conformant instances:

```
<nc:ActivityDate></nc:ActivityDate>
```

OR

```
<nc:ActivityDate/>
```

Nil value allowance or restriction is only significant to elements of non-textual types (e.g., dates and numerics), and elements of text types that have restricted value space (e.g., code). This is because an unrestricted text typed element always contains the empty string (`""`) in its value space. However, for numerics and restricted text type elements, NIEM allows users to tighten constraints as required in IEPDs by resetting `nillable="false"`.

5.6.2. Attribute Declarations

Attribute declarations must be declared with a type by **[Rule 5-10]**, which forbids anonymous type definitions for attributes.

Within an attribute declaration, the attribute `fixed` may be used as per the XML Schema specification. Within an attribute declaration, the attribute `form` is irrelevant to NIEM, as NIEM-conformant schemas may not contain local attribute declarations.

Attribute uses (attribute declarations acting as particles) must be uses of top-level named attributes. NIEM-conformant schemas may not define local named attributes within type definitions. Within an attribute use, the attributes `fixed` and `use` may be used as per the XML Schema specification.

5.6.3. Attribute Group Definitions

In NIEM conformant schemas, use of attribute groups is restricted. The only attribute group that plays a part in NIEM-conformant schemas is `structures:SimpleObjectAttributeGroup`. This attribute group provides the attributes necessary for IDs, metadata, and link metadata.

[Rule 5-57]

Within a NIEM-conformant schema, any occurrence of the element `xsd:attributeGroup` MUST own an attribute `ref`.

[Rationale]

The only attribute group used in NIEM-conformant schemas is `structures:simpleObjectAttributeGroup`. Therefore, NIEM-conformant schemas do not define additional attribute groups.

[Rule 5-58]

Within a NIEM-conformant schema, the attribute `ref` owned by any element `xsd:attributeGroup` MUST have a value of a qualified name (possibly using the default namespace) that SHALL resolve to the namespace for the NIEM `structures` namespace and the local name `SimpleObjectAttributeGroup`.

[Rationale]

The only attribute group used within NIEM-conformant schemas is `structures:SimpleObjectAttributeGroup`. Therefore, within a NIEM conformant schema, only this attribute group can be referenced.

6. Modeling Rules

NIEM provides a framework for modeling concepts and relationships as XML artifacts. The data model is implemented via XML Schema. However, XML Schema does not provide sufficient structure and constraint to enable translating from a conceptual model to a schema, and then to instances of the concepts. NIEM provides additional support for modeling concepts as schemas, and provides rules for creating and connecting data that realizes those concepts.

[Definition: NIEM-conformant schema]

> A **NIEM-conformant schema** is an XML document which follows the rules for NIEM-conformant schemas, as provided by this document. Any schema that follows all of the rules may be called NIEM-conformant.

Underlying the NIEM data model are two namespaces: the `structures` namespace and the `appinfo` namespace. These two namespaces provide schema components that serve two functions:

1. They provide support for connecting structural definitions to concepts
2. They provide base components from which to derive structural definitions.

These namespaces are distributed with the NIEM data model content, but are not themselves considered to be content of the data model. They are instead, part of the structure on which the data model is built.

6.1. `xsd:schema` Document Element Restrictions

[Rule 6-1]

> Within a NIEM-conformant schema, the document element `xsd:schema` MUST have application information `appinfo:ConformantIndicator`, with text content "`true`".

Rationale

> The `appinfo:ConformantIndicator` element is how NIEM-conformant schemas indicate that they are, in fact NIEM-conformant. Without such an indicator, conformance would have to be "guessed" by readers and processors.

[Rule 6-2]

> Two XML schemas SHALL have the same value for attribute `targetNamespace` carried by the element `xsd:schema` if and only if they represent the same set of components.

[Rule 6-3]

> Two XML Schemas SHALL have the same value for attribute `targetNamespace` carried by the element `xsd:schema`, and different values for attribute `version` carried by the element `xsd:schema` if and only if they are different views of the same set of components.

Rationale

> These rules embody the basic philosophy behind NIEM's use of namespaced components: A component is uniquely identified by its class (e.g. element, attribute, type), its namespace (a URI), and its local name (an unqualified string). Any two matching component identifiers refer to the same component, even if the versions of the schemas containing each are different.

6.2. Annotations

NIEM-conformant schemas define data models for the purpose of information exchange. A major part of defining data models is the proper definition of the contents of the model. What does a component mean, and what might it contain? How should it be used? NIEM-conformant schemas contain the invariant part of the definitions for the data model. The set of definitions includes:

1. A text definition of each component. This describes what the component means.
2. The structural definition of each component. This is made up of XML Schema components.

When possible, meaning is expressed via XML Schema mechanisms: type derivation, element substitution, specific types and structures, as well as names that are trivially parseable. Beyond that, NIEM-specific syntax must be used, as discussed in this section.

6.2.1. Human-Readable Documentation

By other rules, a schema component must contain at most one element `xsd:annotation`. An element `xsd:annotation` in turn must contain at most one element `xsd:documentation`. The content of the element `xsd:documentation` on a component is the definition for the component.

[Rule 6-4]

> Within a NIEM-conformant schema, any type definition MUST be a documented component.

[Rule 6-5]

> Within a NIEM-conformant schema, any element declaration MUST be a documented component.

[Rule 6-6]

> Within a NIEM-conformant schema, any attribute declaration MUST be a documented component.

[Rule 6-7]

> Within a NIEM-conformant schema, the element `xsd:enumeration` MUST be a documented component.

[Rule 6-8]

> Within a NIEM-conformant schema, the document element `xsd:schema` MUST be a documented component.

Note that **[Rule 4-4]** applies **[ISO 11179 Part 4]** definition rules to documented components.

[Rule 6-9]

> Words or synonyms for the words within a data element definition MAY be reused as terms in the corresponding component name, if those words do not dilute the semantics and understanding of, or impart ambiguity to, the entity or concept that the component represents.

[Rule 6-10]

> An object class SHALL have one and only one associated semantic meaning (i.e. a single word sense.) as described in the definition of the component that represents that object class.

[Rule 6-11]

An object class SHALL NOT be redefined within the definitions of the components that represent properties or subparts of that entity or class.

Rationale

Data definitions should be concise, precise, and unambiguous without embedding additional definitions of data elements that have already been defined once elsewhere (such as object classes). **[ISO 11179 Part 4]** says that definitions should not be nested inside other definitions. Furthermore, a data dictionary is not a language dictionary. It is acceptable to reuse terms (object class, property term, and qualifier terms) from a component name within its corresponding definition to enhance clarity, as long as the requirements and recommendations of **[ISO 11179 Part 4]** are not violated. This further enhances brevity and precision.

[Rule 6-12]

A NIEM data definition SHALL NOT contain explicit representational or data typing information such as number characters, type of characters, etc., unless the very nature of the component can only be described by such information.

Rationale

A component definition is intended to describe semantic meaning only, not representation or structure. How a component with simple content is represented is indicated through the representation term and further refined through constraints.

Example 1

```
<xsd:element name="AngularMinuteValue" type="nc:AngularMinuteType"
             nillable="true">
  <xsd:annotation>
    <xsd:documentation>
      A value that specifies a minute of a degree. The value comes
      from a restricted range of 0 (inclusive) to 60 (exclusive).
    </xsd:documentation>
  </xsd:annotation>
</xsd:element>
```

In Example 1 above, the component definition contains representational information because the component is mathematical and therefore requires such. In Example 2 below, the definition is incorrect and states unnecessary representational information about the data element. `nc:PersonSSNIdentification` is not a Social Security Number (SSN); it is a complex element (type `nc:IdentificationType`) that contains a SSN identifier as well as other properties that describe a person's SSN identifier (such as issue date, issue authority, etc.). The phrase "9-digit" is incorrect and unnecessary because it only applies to the SSN identifier and should be applied as a length or pattern constraint on the identifier only.

Example 2

```
<xsd:element name="PersonSSNIdentification" type="nc:IdentificationType">
  <xsd:annotation>
    <xsd:documentation>
      A social security number that references a person; a 9-digit
      numeric identifier assigned to a living person by the United
      States Social Security Administration.
    </xsd:documentation>
  </xsd:annotation>
</xsd:element>
```

[Rule 6-13]

A component definition SHALL begin with a standard opening phrase that depends on the class of the component per Table 1: Standard Opening Phrases:

Table 1: Standard Opening Phrases

ThisComponent Class	Definition opening phrase
Abstract	"A data concept for a …"
Association	"A relationship …"
Augmentation	"Supplements …"
Entities and properties of such	"A (An) …"
Indicator	"True if …; false otherwise/if…"
Role	"Acts as …"
Type	"A data type for …"
Role	"Acts as …"

Rationale

A standard opening phrase base on component class helps to ensure consistent definitions that appropriate for the type of component item being defined. These opening phrases also provide a cue that facilitates recognition of the particular kind of component.

6.2.2. Machine-Readable Annotations

XML Schema provides *application information* schema components to provide for automatic processing and machine-readable content for schemas. NIEM utilizes application information to convey information that is outside schema definition, and outside human-readable text definitions. NIEM uses application information to convey high-level data model concepts and additional syntax to support the NIEM conceptual model and validation of NIEM-conformant XML instances.

NIEM defines a single namespace which holds components for use in NIEM-conformant schema application information. This namespace is referred to as the `appinfo` namespace.

[Definition: appinfo namespace]

The **appinfo namespace** is the namespace represented by the URI "`http://niem.gov/niem/appinfo/2.0`".

The `appinfo` namespace defines elements which provide additional semantics and syntactic guidelines for components built by NIEM schemas.

[Rule 6-14]

A NIEM-conformant schema SHALL import the `appinfo` namespace.

Rationale

For uniformity, all NIEM-conformant schemas must import the appinfo namespace.

[Definition: application information]

A component is said to have **application information** of some element **E** when the root element that defines the component has an immediate child element `xsd:annotation`, which has an immediate child element `xsd:appinfo`, which has as an immediate child the element **E**.

If a component is described as "having application information", this means that the application information elements under consideration are children of the element which defines the component.

The majority of uses of application information from the `appinfo` namespace are described in the modeling rules for the specific component.

6.2.2.1. Deprecation

The `appinfo` schema provides a construct for indicating that a construct is deprecated. A deprecated component is one whose use is not recommended. A deprecated component is kept in a schema for support of older versions, but should not be used in new efforts. A deprecated component will be removed, replaced or renamed in a later edition of a schema.

[Definition: deprecated component]

In a particular NIEM-conformant namespace, a **deprecated component** is one whose use is not recommended, yet which is maintained in the schema for compatibility with previous versions of the namespace.

[Rule 6-15]

A component which is deprecated SHALL be indicated as such by the component having application information `appinfo:Deprecated`, with an attribute `value` with a value of `true`.

Rationale

Deprecation can allow version management to be more consistent; versions of schema may be incrementally improved, without introducing validation problems and incompatibility. As XML Schema lacks a deprecation mechanism, NIEM defines such a mechanism.

6.2.2.2. Indicating Conformance

The element `appinfo:ConformantIndicator` is used for two purposes.

1. To indicate that a schema is conformant, or that it represents a conformant namespace.
2. To indicate that an imported schema is not conformant, or represents a non-conformant namespace.

The specific rules concerning this element appear in Section 6.1, `xsd:schema` Document Element Restrictions, and Section 6.6, Using External Schemas.

6.2.2.3. Bases of Derived Components

The `appinfo` namespace provides an annotation for indicating the base of a derived component. This is expressed via the `appinfo:Base` application information.

[Rule 6-16]

Within a NIEM-conformant schema, the element `appinfo:Base` MAY be used in one of the following ways:

1. By a type definition, to indicate the base type, or `structures:Object` or `structures:Association`, or
2. By an element declaration, to indicate the base element

The element `appinfo:Base` SHALL NOT be used for any other purpose.

Rationale

The `appinfo:Base` element is required to clarify semantics of types as object or association types, when such derivation is not otherwise derivable from the component definitions.

[Rule 6-17]

Within a NIEM-conformant schema, the element `appinfo:Base` SHALL indicate, by namespace and name, one of the following:

1. a NIEM-conformant schema component, or
2. `structures:Object`, or
3. `structures:Association`.

[Rule 6-18]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` owned by an element `appinfo:Base` SHALL have a value of either:

1. a namespace which is the target namespace of a NIEM-conformant schema, or
2. the `structures` namespace.

[Rule 6-19]

Within a NIEM-conformant schema, an element `appinfo:Base` which does not own an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-20]

Within a NIEM-conformant schema, an element `appinfo:Base` SHALL own an attribute `appinfo:name`.

[Rule 6-21]

Within a NIEM-conformant schema, if an element `appinfo:Base` indicates a NIEM-conformant namespace, then the value of the attribute `appinfo:name` owned by the element `appinfo:Base` SHALL indicate a schema component in the indicated namespace.

[Rule 6-22]

Within a NIEM-conformant schema, if an element `appinfo:Base` indicates the structures namespace, then the value of the attribute `appinfo:name` owned by the element `appinfo:Base` SHALL have a value of one of:

1. `structures:Object`, or
2. `structures:Association`, or

3. a schema component defined by the `structures` schema.

Rationale

Together, this set of rules establishes the element `appinfo:Base` as a reference to either a NIEM-conformant schema component, or to a special NIEM component, which acts as the base for the containing schema component. .

6.2.2.4. Application of Constructs

NIEM schemas provide capability for modeling beyond that provided by basic XML Schema. Two methods made available by NIEM are augmentations and metadata. Both of these methods create schema components which may be applied to types in specific ways. The applicability of these components to types is expressed with the `appinfo:AppliesTo` element.

[Rule 6-23]

Within a NIEM-conformant schema, the element `appinfo:AppliesTo` MAY be used in any of the following ways:

1. To indicate a base type to which an augmentation may be applied
2. To indicate a base type to which a metadata type may be applied

The element `appinfo:AppliesTo` SHALL NOT be used for any other purpose.

Rationale

The `appinfo:AppliesTo` element is required to express constraints beyond those available within XML Schema. Use of this element allows advanced processing of instances and schemas for type-safety.

[Rule 6-24]

Within a NIEM-conformant schema, the element `appinfo:AppliesTo` SHALL indicate a schema component, by namespace and name.

[Rule 6-25]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` owned by an element `appinfo:AppliesTo` SHALL indicate the namespace of the type to which `appinfo:AppliesTo` refers. The indicated namespace SHALL be NIEM-conformant.

[Rule 6-26]

The type to which the attribute `appinfo:appliesTo` refers MUST be the indicated type or MUST be transitively derived from the indicated type.

[Rule 6-27]

Within a NIEM-conformant schema, an element `appinfo:AppliesTo` which does not carry an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-28]

Within a NIEM-conformant schema, an element `appinfo:AppliesTo` SHALL carry an attribute `appinfo:name`. The value of this attribute SHALL indicate the local name of a schema component within the namespace specified by the element.

Rationale

Together, this set of rules establishes the element `appinfo:AppliesTo` as a reference to a NIEM-conformant schema component to which a NIEM construct may be applied.

6.2.2.5. Targets of References

NIEM provides references, in order to avoid problems occurring when only XML element containment is available. The `appinfo:ReferenceTarget` element specifies the type to which a reference element may be applied.

[Rule 6-29]

Within a NIEM-conformant schema, the element `appinfo:ReferenceTarget` SHALL specify the type of a schema component which an instance of a reference element references. The element `appinfo:ReferenceTarget` SHALL NOT be used for any other purpose.

[Rule 6-30]

A reference element SHALL reference an instance of the indicated type, or an instance of a type derived from that type.

Rationale

The element `appinfo:ReferenceTarget` is required to express the type of referenced content. This level of type-safety is not provided by XML Schema.

[Rule 6-30.1]

Within a NIEM-conformant schema, a reference element MUST have at most one instance of the element `appinfo:ReferenceTarget.`

Rationale

Content elements in XML Schema may have at most one type. This rule ensures that reference elements follow the same pattern.

[Rule 6-31]

Within a NIEM-conformant schema, the element `appinfo:ReferenceTarget` SHALL indicate a type definition schema component, by namespace and name.

[Rule 6-32]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` carried by an element `appinfo:ReferenceTarget` SHALL indicate the namespace of the referenced schema component. The indicated namespace SHALL be NIEM-conformant.

[Rule 6-33]

Within a NIEM-conformant schema, an element `appinfo:ReferenceTarget` which does not carry an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-34]

Within a NIEM-conformant schema, an element `appinfo:ReferenceTarget` SHALL carry an attribute `appinfo:name`. The value of this attribute SHALL indicate the local name of a type definition schema component within the namespace specified by the element.

Rationale

Together, this set of rules establishes the element `appinfo:ReferenceTarget` as a reference to a NIEM-conformant type definition schema component which a reference element instance may reference.

6.3. Complex Type Definitions

Under XML Schema rules, a CCC (complex type with complex content) may not be the base type of a CSC (complex type with simple content), and a CSC may not be a base for a CCC. Therefore, NIEM defines one pattern for defining a CCC, and a different pattern for defining a CSC. These patterns supply common base definitions that will be provided for CSCs and CCCs. These patterns are established by the rules for use of `xsd:extension` in `xsd:complexContent` and `xsd:simpleContent` elements. The relevant rules may be found in Sections 5.5.3, Simple Content (CSC) Restrictions, and 5.5.4, Complex Content (CCC) Restrictions.

[Rule 6-35]

Within a NIEM-conformant schema, a complex type definition SHALL be one of the following classes of types:

1. An object type
2. A role type
3. An association type
4. A metadata type
5. An augmentation type
6. An adapter type.

Rationale

This rule establishes the classes of NIEM complex types. It is a limited set, each class with distinct semantics.

The first five types are described in subsections below. The adapter type is described in Section 6.6, Using External Schemas.

[Rule 6-36]

Within a NIEM-conformant schema, an element MUST NOT be introduced more than once into the direct content of a type definition. This applies to content acquired through extension of base types. This does not apply to a base element or derived element to one previously existing in the type definition.

Rationale

This rule ensures that sequences of elements are simple sequences. A type should not define, for example, a sequence of elements A, B, then A again. Definitions should define, instead, what elements may be included, and their cardinality. Specific orders should be expressed in instances, when necessary, by the use of the attribute `structures:sequenceID`.

6.3.1. Object Types

[Definition: object type]

In a NIEM-conformant schema, an **object type** is a complex type definition, an instance of which asserts the existence of an object. An object type represents some kind of object: a thing with its own lifespan that has some existence. The object may or may not be a physical object. It may be a conceptual object.

[Rule 6-37]

Within a NIEM-conformant schema, an object type SHALL be a complex type definition that has one of the following forms:

1. Has simple content, is based on a simple type, and contains the attribute group `structures:SimpleObjectAttributeGroup`, and has application information `appinfo:Base` of `structures:Object`, or
2. Has complex content, and is based on complex type `structures:ComplexObjectType`, and has application information `appinfo:Base` of `structures:Object`, or
3. Is a complex type that is derived from an object type, which is defined according to this rule.

Rationale

Object types are at the core of NIEM. They are built in a uniform way, from a simple design pattern: they take one of the two "root" forms outlined above, or they are built from other object types, depending on whether they are of simple or complex content.

6.3.2. Role Types

NIEM differentiates between an object and a role of the object. The term "role" is used here to mean a function or part played by some object.

[Definition: role type]

A **role type** is a type that represents a particular function, purpose, usage, or role of an object.

The simplest way to represent a role of an object is to use an element. The following example represents the role of a person who performs an assessment:

```
<xsd:element name="AssessmentPerson" type="nc:PersonType"/>
```

In many cases, there is a further need to represent characteristics and additional information associated with a role of an object. In such cases, the above element is insufficient. For example, when a person is a driver involved in a automotive crash, the person plays the role of a `j:CrashDriver`. In the case of a crash, there is more information associated with the role of the driver than just his identity for the role. One such example would be the traffic violation code, `j:CrashDriverViolationCode` is frequently a characteristic property of a `j:CrashDriver`. For this reason, a role type, `j:CrashDriverType` is created.

A role type provides the location for information associated with an object playing a role. A role type is used instead of the base type (in this case, `nc:PersonType`). The role type holds information specific to the role, but not specific to the context or the base object (the object that plays the role). Developers of NIEM-conformant schemas should create and use role types whenever they have non-persistent information specific to a base object. Such information generally expires when the base object is no longer playing the role. Information that is persistent to the base object probably does not belong in a role type.

[Definition: RoleOf element

In a NIEM-conformant schema, a **RoleOf element** is a reference element whose type is the base type of the role.

Here is an example of a role type from the NIEM Justice domain which uses a RoleOf element:

```
<xsd:complexType name="CrashPersonType">
  ...
  <xsd:sequence>
    <xsd:element ref="nc:RoleOfPersonReference" minOccurs="0"
      maxOccurs="unbounded"/>
    ...
    <xsd:element ref="j:CrashPersonInjury" minOccurs="0"
      maxOccurs="unbounded"/>
    ...
    <xsd:element ref="j:AlcoholTestResultCode" minOccurs="0"
      maxOccurs="unbounded"/>
    ...
  </xsd:sequence>
  ...
</xsd:complexType>
```

`nc:RoleOfPersonReference` is defined as “An entity of whom the role object is a function.” In this example, the role object is `j:CrashPersonType` and the base type of the role object is a `nc:PersonType`, the entity of whom `j:CrashPersonType` is a function (per the definition above).

This role object represents a particular role of a person: a person involved in a vehicular crash. It refers to the person of whom this object is a role through the `nc:RoleOfPersonReference` element. It also includes additional information particular to the person's role in the crash.

[Rule 6-38]

> Within a NIEM-conformant schema, any element with a name beginning with the string `RoleOf` SHALL represent a base type, of which the containing type represents a role.

Rationale

> A “RoleOf” element references its corresponding base element. The “RoleOf” label on the reference element ensures that a role object is distinguishable from other objects and its link to the associated base is also distinguishable from the additional properties that are characteristic of this role or that add information.

NIEM does not require that there be only one RoleOf element within a single type. However, the use of multiple RoleOf elements may not make sense, and indeed, an example of a role that references two or more base types is very difficult (if not impossible) to conceive.

An object should be a role of only a single object. However, there may be varied assertions of what object that might be, or time constraints on the role. Many exchanges may wish to restrict RoleOf elements to a single occurrence within a type.

Role elements are generally reference elements, targeting the base type. That is, a role element is usually a reference element, not a content element.

6.3.3. Association Types

Within NIEM, an association is a specific relationship between objects. Associations are used when a simple NIEM property is insufficient to model the relationship clearly and when properties of the relationship exist that are not attributable to the objects being related.

[Definition: association type]

In a NIEM-conformant schema, an **association type** is a type which establishes a relationship between objects, along with the properties of that relationship. An association type provides a structure which does not establish existence of an object, but instead specifies relationships between objects.

[Definition: association]

In a NIEM-conformant schema, an **association** is an element whose type is a association type.

[Rule 6-39]

Within a NIEM-conformant schema, an association type SHALL be a complex type definition that has one of the following forms:

1. Has complex content, is based on the complex type `structures:ComplexObjectType`, and has application information `appinfo:Base` of `structures:Association`, or
2. Is a complex type that is derived from an association type, which is defined according to this rule.

Rationale

Associations are easily identifiable as such, and have a commonly-defined base type.

[Rule 6-40]

Within a NIEM-conformant schema, in an association type, any element which represents a participant in the relationship established by the association type SHALL be a reference element.

Rationale

Associations are intended to relate objects defined elsewhere. They are not intended to carry content of participant objects.

6.3.4. Metadata Types

Within NIEM, metadata is defined as "data about data." This may include information such as the security of a piece of data, or source of the data. These pieces of metadata may be composed into a metadata type. The types of data to which metadata may be applied may be constrained.

[Definition: metadata type]

A **metadata type** describes data about data, that is, information which is not descriptive of objects and their relationships, but is descriptive of the data itself. It is useful to provide a general mechanism for data about data. This provides required flexibility to precisely represent information.

[Definition: metadata element]

Within a NIEM-conformant schema, a **metadata element** is an element whose type is a metadata type. There are specific limitations on the meaning of a metadata element in an instance; it does not establish existence of an object, nor is it a property of its containing object.

[Rule 6-41]

Within a NIEM-conformant schema, a metadata type SHALL contain elements appropriate for a specific class of data about data.

[Rule 6-42]

Within a NIEM-conformant schema, a metadata type and only a metadata type SHALL be derived directly from `structures:MetadataType`.

Rationale

A metadata type establishes a specific, named aggregation of data about data. Any type derived from `structures:MetadataType` is a metadata type. Metadata types should not be derived from other metadata types. Such metadata types should be used as-is, and additional metadata types defined for additional content.

[Rule 6-43]

Within a NIEM-conformant schema, a metadata type MAY have application information `appinfo:AppliesTo`, indicating the NIEM-conformant object, association, or external adapter types to which the metadata applies.

[Rule 6-44]

Within a NIEM-conformant schema, a metadata type which does not have application information `appinfo:AppliesTo` MAY be applied to any object type, association type, or external adapter type.

Rationale

Metadata may be constrained to be applicable to only specific types, or it may be defined to be applicable to any type. Information such as the source of a piece of data, or the security classification of a piece of data are examples of metadata that may be considered globally applicable.

6.3.5. Augmentation Types

Builders of domains and extensions to NIEM distribution schemas need to be able to define extensions to types. However, extension of types by multiple domain schemas and extension schemas proves problematic, as it results in multiple extensions of a single type. XML Schema does not provide for multiple types of an instance, and so such a method results in duplication of base type content, and a need to resolve "same-as" relationships between the instances of the various derived types.

Instead, it is preferable for domains and extensions to provide augmentations. These are reusable types, and elements of those types, which may be added to an object class, in a single extended type, by the author of a NIEM-conformant schema. This avoids the problem of multiple extended types, but allows domains and extensions to define reusable extensions.

Augmentation types such as `dom:PersonAugmentationType` (where `dom`: is a NIEM domain namespace) exist to extend NIEM Core types such as `nc:PersonType` without creating a new specialized object within the model. Augmentation types are never applied within the model to the types they are designed to augment. Doing so would restrict reusing and combining these augmentations.

Instead, augmentation should be applied within IEPDs. So, in an IEPD (NOT within NIEM), base `nc:PersonType` may be extended, for example, as `my-iepd:PersonType` by adding elements `a:PersonAugmentation` and `b:PersonAugmentation`. As a result, `my-iepd:PersonType` will contain all the properties in `nc:PersonType` plus the properties in both of the elements `a:PersonAugmentation` and `b:PersonAugmentation`, which, in turn, each contain their respective sets of sub-elements.

All NIEM augmentation types extend the abstract type `structures:AugmentationType`. Therefore, all augmentation types automatically contain the attributes `structures:id` and `structures:metadata` for referencing and metadata respectively. NIEM also provides the abstract element `structures:Augmentation` (of type `structures:AugmentationType`) as the common substitution group head for all augmentation elements. An augmentation element placed into this substitution group can be used in an instance wherever `structures:Augmentation` occurs in the corresponding IEPD schema. The user must follow NIEM naming conventions for augmentation component names, and must place new augmentation elements into the `structures:Augmentation` substitution group. Furthermore, if an augmentation element cannot be applied to all types in the model, then the user must document those types that the new augmentation element can be applied to using the `appinfo:AppliesTo` element.

[Definition: augmentation type]

An **augmentation type** is a complex type which provides a reusable block of data which may be added to object types or association types.

[Definition: augmentation]

An **augmentation** of a NIEM-conformant object type is a block of additional data added to an object type, in order to carry additional data beyond that of the original object definition.

[Rule 6-45]

An augmentation type:

1. SHALL be transitively derived from `structures:AugmentationType` and
2. SHALL contain elements which represent properties to be applied to a base type.

Rationale

A base type is the type to which an augmentation is to be applied. An augmentation may be applied to any number of types. Base types are assigned by augmentation elements.

[Rule 6-46]

Within a NIEM-conformant schema, an augmentation element definition:

1. SHALL have a type which is an augmentation type
2. SHALL use the `substitutionGroup` attribute such that it is transitively substitutable for the element `structures:Augmentation`

An element which is not an augmentation element SHALL NOT meet either of the above criteria.

Rationale

An augmentation is trivially identifiable as such. The use of the common `structures:Augmentation` element allows message builders to optionally delay specifying augmentations to be applied to a type until runtime.

[Rule 6-47]

Within a NIEM-conformant schema, an element definition for an augmentation element MAY contain one or more instances of the element `structures:AppliesTo` as application information, to specify types to which the augmentation element applies.

[Rule 6-48]

Within a NIEM-conformant schema, an element definition for an augmentation element which does not contain any instances of the element `structures:AppliesTo` MAY be applied to any object or association type.

Rationale

These rules allow schema builders to establish applicability for augmentations. An augmentation may be applicable to specific types.

Users who wish to apply an augmentation type to a given object type may do so by creating a new augmentation element, applicable to the object type.

6.4. Component Usage

[Rule 6-49]

Any type definition referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The XML Schema namespace
4. The `structures` namespace.

Rationale

NIEM-conformant schemas are based on other NIEM-conformant schemas, and the supporting namespaces. This simplifies processing and understanding of data.

[Rule 6-50]

Any element declaration referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The `structures` namespace
4. An external namespace, in accordance with the rules for external schemas as specified by this specification.

[Rule 6-51]

Any attribute declaration referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The `structures` namespace
4. The XML namespace
5. An external namespace, in accordance with the rules for external schemas as specified by this specification.

Rationale

NIEM-conformant schemas are based on other NIEM-conformant schemas. All attributes and elements must be from NIEM-conformant schemas, the `structures` namespace, the XML namespace, or an external namespace. This applies to elements referenced for substitution groups, as well. It does not apply to content of the schema (e.g. within annotations), or to the XML Schema declarations themselves. It applies only to attributes and elements referenced by the XML Schema components.

6.5. NIEM Structural Facilities

NIEM provides the structures schema which contains base types for types defined in NIEM-conformant schemas. It provides base elements to act as heads for substitution groups. It also provides attributes that provide facilities not otherwise provided by XML Schema. These structures should be used to augment XML data. The structures provided are not meant to replace fundamental XML organization methods; they are intended to assist them.

[Definition: structures namespace]

The **structures namespace** is the namespace represented by the URI "`http://niem.gov/niem/structures/2.0`".

The structures namespace is a single namespace, separate from namespaces that define NIEM-conformant data. This document refers to this content via the prefix `structures`.

[Rule 6-52]

A NIEM-conformant schema MUST import the NIEM `structures` namespace.

Rationale

For uniformity, all NIEM-conformant schemas must import the `structures` namespace.

[Rule 6-53]

NIEM-conformant schemas and instances MUST use content within the NIEM structures namespace as specified in this document and ONLY as specified by this document.

Rationale

This rule further enforces uniformity and consistency by mandating use of the NIEM structures namespace as is, without modification. Users are not allowed to insert types, attributes, etc. that are not specified by this document (the NDR).

6.5.1. Sequence ID

NIEM provides the attribute `structures:sequenceID` for specification of sequential order of instances, when a complex type's defined element sequence is insufficient. A limitation of XML Schema is that control of cardinality (the number of times an element may occur in an instance) requires the use of sequences of elements. This use of `xsd:sequence` defines the elements occurring within a type in a specific order. This order may not match the desired sequential order of the represented entities.

An example would be for proper names, where the natural order of the names may not appear in the same order as the sequence defined by a complex type. Consider the example:

- One address represents the postal code before the city name
- Another address represents the city name before the postal code

- The address structure must be defined in exactly one way

Without the `structures:sequenceID` attribute, this example would create a dilemma: which address to represent properly, and which to represent incorrectly? The `structures:sequenceID` attribute allows the schema sequence to be separated from the implied meaning.

As another example, when using a derived type, within an instance, the base type's elements occur first, followed by any elements added by extension. If those elements need to be interleaved into the existing structure for the proper meaning to be conveyed, the `structures:sequenceID` attribute is called for.

The `structures:sequenceID` attribute allows instances to express the sequential order of data relative to a parent. The order of data is as yielded by XSLT's `xsl:sort` element, with data-type of `xsl:number`, and order of `ascending`. Content with identical `structures:sequenceID` values has undefined order.

[Rule 6-54]

> Within a NIEM-conformant schema, a complex type definition SHALL include the attribute `structures:sequenceID` if the order of an occurrence of the type, within its parent, relative to its siblings, is meaningful and pertinent, and if the content presented by all instances defined by the schema will not otherwise occur in the desired sequential order.

Rationale

> This rule indicates that, if order is meaningful, and the schema won't always represent the desired order, then data modelers need to include `sequenceID` to allow the proper order to be represented in instances.

Use of `sequenceID` is restricted by are found in the rules on conformant instances in Section 7.4, Component Ordering.

6.5.2. Reference Elements

In XML instances, relationships between data objects are expressed as XML elements:

1. Data objects are expressed as XML elements, and
2. XML elements contain attributes and other elements.

In this way, there is generally some implicit relationship between the outer element (the "containing" element, a.k.a. the parent element) and the inner elements (the "contained" elements, a.k.a. the child elements). Such expression of relationships is said to be by containment.

Expression of all relationships via element containment is not always possible. Situations that cause problems include:

- Circular relationships. For example, suppose Object1 has a relationship to Object2 and Object2 has a relationship to Object1. Expressed via containment, this relationship would result in infinite recursive descent.
- Repeated relationships. For example, suppose Object1 has a relationship to Object2 and Object3 has a relationship to Object2. Expressed via containment, this would result in a duplicate of Object2.

A method that solves this problem is to use references. In a C or assembler, a pointer would be used. In C++, a reference might be used. In Java, a reference value might be used. The method defined by the XML standard is the use of `ID` and `IDREF`. An `ID` refers to an `IDREF`. NIEM uses this method, and assigns to it specific semantics.

[Definition: reference element]

A **reference element** is an element that refers to its value by a reference attribute, instead of carrying it as content.

[Rule 6-55]

Within a NIEM-conformant schema, a reference element and only a reference element SHALL be defined to be of type `structures:ReferenceType`.

Rationale

Reference elements must be of the reference type, and elements of the reference type must be reference elements. This rule ensures that users always create reference elements using `structures:ReferenceType`, and cannot use `structures:ReferenceType` for any other purpose.

[Rule 6-56]

Within a NIEM-conformant schema, a complex type SHALL NOT be defined such that an instance of that type owns the attribute `structures:ref`.

Rationale

The use of references is limited to reference elements. This constrains the semantics and syntax of references within NIEM instances. Only `structures:ReferenceType` may use `structures:ref`, which is the only means for referencing within NIEM-conformant instances.

[Rule 6-57]

Within a NIEM-conformant schema, any two elements of the form

NCName

and

NCName`Reference`

where the string value of *NCName* is the same in both forms, SHALL be defined to have identical semantics. The NIEM recognizes no difference in meaning between a reference element and an element that is not a reference element.

Rationale

NIEM-conformant data instances may use concrete data elements and reference elements as needed, to represent the meaning of the fundamental data. There is no difference in meaning between reference or concrete data representations. The two different methods are available for ease of representation. No difference in meaning should be implied by the use of one method or the other.

Assertions that indicate "included" data is intrinsic, while referenced data is extrinsic are not valid and are not applicable to NIEM-conformant data instances and data definitions.

[Rule 6-58]

Within a NIEM-conformant schema, if both elements *NCName* and *NCName*`Reference` exist, then the `appinfo:ReferenceTarget` of any *NCName*`Reference` element MUST be the type of the element *NCName*.

Rationale

By **[Rule 6-57]**, any such pair of elements, *NCName* and *NCName*`Reference`, will have identical semantics. This rule ensures that a *NCName*`Reference` element is documented to refer to the appropriate type (the type of the corresponding *NCName* element) and no other.

The NIEM structures schema defines `structures:ReferenceType` to require the use of an attribute `structures:ref`, which is of type `IDREF` as specified by **[XMLSchemaStructures]**. According to the rules of XML, such an attribute must contain a value that is represented by an attribute of type `ID`. In NIEM-conformant instance, the targets of `IDREFs` are expected to be values of the attribute `structures:id`.

The NIEM structures schema defines `structures:ReferenceType` such that it is unavailable as a base for extension or restriction.

The NIEM structures schema defines `structures:ReferenceType` such that it has an optional attribute `structures:id`. This may be used to describe additional metadata or information about the relationship described by an element of type `structures:ReferenceType`.

Within a NIEM-conformant instance, the element referenced by an attribute `structures:ref` must be of a type valid for the object of the fundamental element of the reference element. The attribute `structures:ref` is discussed in more detail in Section 7.3.

6.6. Using External Schemas

There are a variety of commonly-used standards that are represented in XML Schema. Such schemas are generally not NIEM-conformant. NIEM-conformant schemas may reference components defined by these external schemas. NIEM-conformant components may be constructed from non-NIEM schema components.

[Definition: external schema]

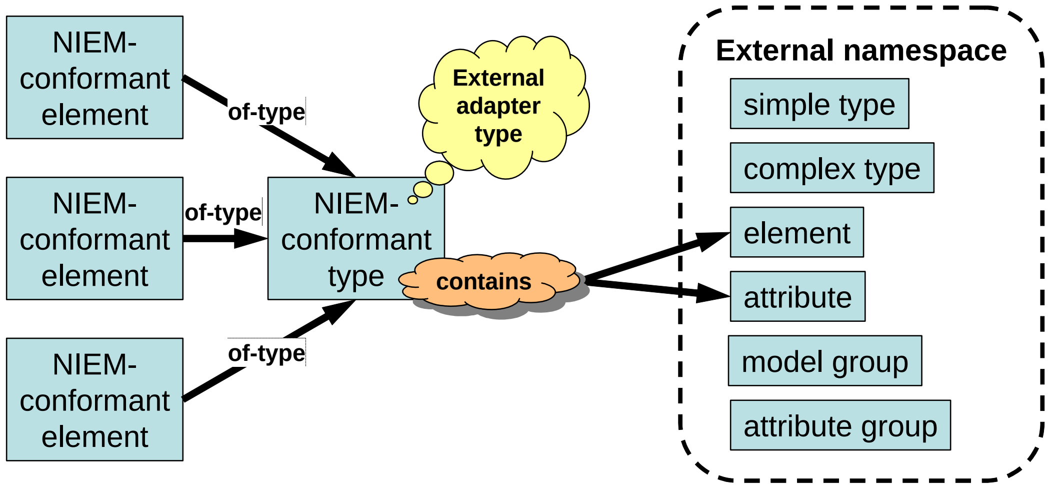
An **external schema** is any non-supporting schema that is not NIEM-conformant.

Note that the supporting schemas `structures` and `appinfo` are non-conformant because they define the fundamental framework on which NIEM is built. However, they are not considered external schemas because of their supporting nature, and are thus excluded from this definition.

NIEM-conformant schemas may work with external schemas by creating external adapter types.

A single method is used to integrate external components into NIEM-conformant schemas: NIEM-conformant types are constructed from the external components.

Use of external components to create a NIEM-conformant type



Components defined by external schemas are called *external components*. External components may be used by a NIEM-conformant type in a specific way: to construct a NIEM-conformant type from external components. The goal in this method is to preserve as a single unit a set of data that embodies a single *concept* from an external standard.

For example, a NIEM-conformant type may be created to represent a bibliographic reference from an external standard. Such an object may be composed of multiple elements and types from the external standard. These pieces are put together to form a single NIEM-conformant type. For example, an element representing an author, a book, and a publisher may be included in a single bibliographic entry.

A NIEM-conformant type built from these components may be used as any other NIEM-conformant type. That is, elements may be constructed from such a type, and those elements are fully NIEM-conformant.

To construct such a component, a NIEM-conformant schema must first import an external schema.

[Rule 6-59]

Within a NIEM-conformant schema, an element `xsd:import` that imports a namespace defined by an external schema MUST have the application information `appinfo:ConformantIndicator`, with a value of `false`.

Rationale

Knowledge of the conformance of an imported schema allows processors to understand the semantics of referenced components, without additional processing. Namespaces imported into NIEM-conformant schemas are assumed to be conformant, unless otherwise indicated.

[Rule 6-60]

Within a NIEM-conformant schema, an element `xsd:import` that imports a namespace defined by an external schema MUST be a documented component.

Rationale

A NIEM-conformant schema has well-known documentation points. Therefore, a schema that imports a NIEM-conformant namespace need not provide additional documentation. However, when an external schema is imported, appropriate documentation must be provided at the point of import, because documentation associated with external schemas is undefined and variable. In this particular case, documentation of external schemas is required at their point of use in NIEM.

[Definition: adapter type]

An **adapter type** is a NIEM-conformant type that adapts external components for use within NIEM. An adapter type creates a new class of object that embodies a single concept composed of external components. An adapter type is defined by a NIEM-conformant schema.

[Rule 6-61]

Within a NIEM-conformant schema, an adapter type MUST have application information `appinfo:ExternalAdapterTypeIndicator` with a value of `true`. A type that is not an adapter type SHALL NOT contain that indicator.

Rationale

This rule flags as external adapters those types which may contain external content. This allows for easier processing.

[Rule 6-62]

Within a NIEM-conformant schema, an adapter type MUST be a immediate extension of type `structures:ComplexObjectType`.

Rationale

The adapter type must contain the content defined for any NIEM component. Such content is provided by the complex object type from the `structures` namespace.

[Rule 6-63]

Within a NIEM-conformant schema, an adapter type MUST be composed of only elements and attributes from an external standard.

Rationale

An adapter type should contain the information from an external standard to express a complete concept. This expression should be composed of content entirely from an external schema. Most likely, the external schema will be based on an external standard, with its own legacy support.

In the case of an external expression that is in the form of model groups, attribute groups, or types, additional elements and type components may be created in an external schema, and those components may be used by the adapter type.

[Rule 6-64]

Within a NIEM-conformant schema, an element reference used in an adapter type definition MUST be a documented component.

[Rule 6-65]

Within a NIEM-conformant schema, an attribute reference used in an adapter type definition MUST be a documented component.

Rationale

In normal (conformant) type definition, a reference to an attribute or element is a reference to a documented component. Within an adapter type, the references to the attributes and elements being adapted are references to undocumented components. These components must be documented to provide comprehensibility and interoperability. Since documentation made available by non-conformant schemas is undefined and variable, documentation of these components is required at their point of use, within the conformant schema.

[Rule 6-66]

Within a NIEM-conformant schema, an adapter type MUST NOT be extended or restricted.

Rationale

Adapter types are meant to stand alone; each type expresses a single concept from an external schema, and adapter types are maintained in separate schemas which only contain adapter types. In this way, processors may easily switch modes, processing NIEM-conformant content in one way, and external content in another.

6.7. Container Elements

All NIEM properties establish a relationship between the object holding the property and the value of the property. For example, an activity object of type `nc:ActivityType` may have an element `nc:ActivityDescriptionText`. This element will be of type `nc:TextType` and represents a NIEM property owned by that activity object. An occurrence of this element within an activity object establishes a relationship between the activity object and the text: the text is the description of the activity.

In a NIEM-conformant instance, an element establishes a relationship between the object that contains it and the element's value. This relationship between the object and the element may be semantically-strong, such as the text description of an activity in the previous example, or it may be semantically-weak, with its exact meaning left unstated. In NIEM, the contained element involved in a weakly-defined semantic relationship is commonly referred to as a **container element**.

A container element establishes a weakly-defined relationship with its containing element. For example, an object of type `nc:ItemDispositionType` may have a container element `nc:Item` of type `nc:ItemType`. The container element `nc:Item` does not establish what relationship exists between the object of `nc:ItemDispositionType` and itself. There could be any of a number of possible semantics between an object and the value of a container element - It could be a contained object, a subpart, a characteristic, or some other relationship. The appearance of this container element inside the `nc:ItemDispositionType` merely establishes that the disposition has an item.

The name of the container element is usually based on the NIEM type that defines it: `nc:PersonType` uses a container element `nc:Person`, while `nc:ActivityType` uses a container element `nc:Activity`. The concept of an element as a container element is a notional one.

There are no formalized rules addressing what makes up a container element. A container element is vaguely defined, and carries very little semantics about its context and its contents. Accordingly, there is no formal definition of container elements in NIEM: There are no specific artifacts which define a container element; there are no `appinfo` or other labels for container elements.

The appearance of a container element within a NIEM type carries no additional semantics about the relationship between the property and the containing type. Use of container elements indicate only that there is a relationship, but does not provide any semantics for interpreting that relationship.

For example, a NIEM container element `nc:Person` would be associated with the NIEM type `nc:PersonType`. The use of the NIEM container element `nc:Person` in a containing NIEM type indicates that a person has some association with the instances of the containing NIEM type. But because the `nc:Person` container element is used, there is no additional meaning about the association of the person and the instance containing it. While there is a person associated with the instance, nothing is known about the relationship except its existence.

The use of the Person container element is in contrast to a NIEM property named `nc:AssessmentPerson`, also of NIEM type `nc:PersonType`. When the NIEM property `nc:AssessmentPerson` is contained within an instance of a NIEM type, it is clear that the person referenced by this property was responsible for an assessment of some type, relevant to the exchange being modeled. The more descriptive name, `nc:AssessmentPerson`, gives more information about the relationship of the person with the containing instance, as compared to the semantic-free implications associated with use of the `nc:Person` container element.

When a NIEM-conformant schema requires a new container element, it may define a new element with a concrete type and a general name, with general semantics. Any schema may define a container element when it requires one. NIEM-conformant schemas may also create reference elements with general semantics. For example, an element `nc:PersonReference` will carry the same general, container-like meaning as an element `nc:Person`.

7. XML Instance Rules

This specification attempts to restrict XML instance data as little as possible, while still maintaining interoperability.

[Definition: NIEM-conformant document]

A **NIEM-conformant document** is an XML information set whose document element is defined by a NIEM-conformant schema, and which follows the rules for conformant element information items as specified by this document.

The terms "XML information set", "document element", and "element information item" come from **[XMLInfoSet]**. This definition says that any XML instance whose document element is a conformant element instance is a NIEM-conformant document. The word *document* is meant only as used in **[XMLInfoSet]**.

[Definition: NIEM-conformant element instance]

A **NIEM-conformant element instance** is an XML information item which is defined by a NIEM-conformant schema, and which follows the rules for conformant instance data as specified by this document.

XML data may be referred to as a NIEM-conformant instance if it conforms to this specification.

The NIEM does not require a specific encoding, or specific requirements for the XML prologue, except as specified by **[XML]**.

7.1. Instance Validation

[Rule 7-1]

A NIEM-conformant instance MUST validate to an authoritative NIEM-conformant schema set for namespaces contained in the instance, and for additional namespaces required for validation.

Rationale

The schemas which define the exchange must be authoritative. That is, they must be the reference schema for the namespaces concerned. Other schemas may be used by application developers for various purposes, but for the purposes of determining conformance, the authoritative schemas are relevant.

NIEM embraces the use of XML schema instance attributes, including `xsi:type`, `xsi:nil`, and `xsi:schemaLocation`, as specified by **[XMLSchemaStructures]**.

7.2. Instance Meaning

[Rule 7-2]

Within a NIEM-conformant instance, the meaning of an element with no content is that additional properties are not asserted. There SHALL NOT be additional meaning interpreted for an element with no content.

Rationale

Elements without content only show a lack of asserted information. That is, data which is not there is not stated. It may be due to lack of availability, lack of knowledge, or deliberate withholding of information. If expression of such cases is required, it should be modeled explicitly.

7.3. Component Representation

NIEM uses element containment for the majority of its data representation needs. That is, an element containing another element. In general, one object (the content of the outer element) has a relationship (defined by the name of the inner element) to another object (the content of the inner element).

Example of element containment

```
<OuterElement>
  <!-- object1: the content of outer element -->
  <InnerElement>
     <!-- object2: the content of inner element -->
  </InnerElement>
  <!-- object1, continued -->
</OuterElement>
```

This use of the element containment method has limitations. Specifically, recursive and symmetric relationships (direct or transitive) create difficulties, such as repetition of data, and resolution of duplicates.

To avoid these problems, NIEM allows references between elements. In this way, one object (the content of one element) has a relationship (defined by the name of the inner element) to another object (the content of an element referenced by an attribute of the inner element).

Example of element reference

```
<OuterElement>
  <!-- object1: the content of outer element -->
  <InnerElementReference structures:ref="object2"/>
  <!-- object1, continued -->
</OuterElement>

<OtherElement structures:id="object2">
   <!-- object2: the content of other element -->
</OtherElement>
```

[Rule 7-3]

Within a NIEM-conformant element instance, there SHALL NOT be any difference in meaning between a property asserted via element containment and a property asserted by element reference, except as explicitly described by the semantics of the elements involved.

Rationale

There is no difference in meaning between relationships established by containment, and those established by reference. They are simply two mechanisms for expressing connections between objects. Neither mechanism implies that properties are intrinsic or extrinsic. Such characteristics must be explicitly stated in property definitions.

Being of type `xsd:ID` and `xsd:IDREF`, validating schema parsers will perform certain checks on the values of `structures:id` and `structures:ref`. Specifically, no two IDs may have the same value. This includes `structures:id` and other IDs that may be used in an instance. Also, any value of `structures:ref` must also appear as the value of an ID.

[Rule 7-4]

Any attribute `structures:ref` MUST have a value which occurs as the value of an attribute `structures:id` within the same information set.

Rationale

This states that in NIEM-conformant content, `structures:ref` attributes must refer to `structures:id` attributes. This rule ensures that the target of a reference exists within the same XML instance.

Reference element definitions may include constraints on the type of object which may be referenced by that element.

[Rule 7-5]

Within a NIEM-conformant element instance, given that a reference element is restricted to a set S of target types T_i, $S = \{ T_1, T_2, ..., T_n\}$, any attribute `structures:ref` MUST indicate the value of an attribute `structures:id` which is owned by an element of a type T such that T is, or is derived from, some type T_i in S.

Rationale

This rule says that the type of the object pointed to by an `structures:ref` attribute must be of a type specified by the reference element definition. The restriction of types is defined in the application information of the reference element definition by the use of the `appinfo:ReferenceTarget` attribute.

7.4. Component Ordering

An instance may express the natural order of components by using the order of content within an XML file. It may also use the `structures:sequenceID` to indicate the order of components.

[Rule 7-6]

The order of elements that are children of a NIEM-conformant element SHALL be presented as if their sequential order is as follows:

1. First, elements owning an attribute `structures:sequenceID`, in the order that would be yielded with their sequence IDs sorted via XSLT's `sort` element, with a data type of `number` and an order of `ascending`.
2. Following those elements, the remaining elements, in the order in which they occur within the XML instance.

Rationale

Because of NIEM's use of structured, defined types, and its use of `xsd:sequence`, as well as various representation mechanisms, the order of data within an XML instance may require more precise definition, and may vary from instance to instance. The true order of objects (such as parts of a name, or lines in an address, or parts of a phone number) may need an explicit method to define their order.

In this definition, the term "presented" may mean presentation to the user, reports, or transfer to other data systems. It is meaningful only when the order of appearance of items within a sequence is expressed. Such an order is only the default for the content within an instance. It may be overruled by any meaningful sorting or other processing.

[Rule 7-7]

Within a NIEM-conformant schema or instance, the attribute `structures:sequenceID` SHALL NOT be interpreted as meaningful beyond an indicator of sequential order of an object relative to its siblings.

Rationale

Siblings of a data item are items that have the same parent. Note that, using the reference and relationships mechanisms, data objects may have multiple parents. The sequenceID is truly metadata, helping to express the structure of the data, rather than its content.

Note that reference elements have the same semantics as concrete data elements, and so follow the same rules for sequential order. By using reference elements, an entity may have one order within one structure, and another order within another structure.

Within NIEM-conformant instances, the order of objects is found be given by sorting the objects by numerical value of their respective attribute `structures:sequenceID`, from smallest to highest. The relative order of objects with equal values for `structures:sequenceID` is their order within the XML instance. Objects with no value for `structures:sequenceID` occur after all objects that have values for `structures:sequenceID`, in their relative order within the XML instance.

The use of instance-based sequencing, including the use of `structures:sequenceID`, is preferred over efforts to sequence data definitions. For example, the use of "address line 1", "address line 2", "address line 3", etc, is not recommended. Instead, a single "address line" would be preferred, with order expressed in the XML instance.

7.5. Instance Metadata

NIEM provides the metadata mechanism for giving information about object assertions. An object may have an attribute which refers to one or more metadata objects.

Example of metadata

```
<Person>
  <PersonName>
    <PersonGivenName structures:metadata="M1">John</PersonGivenName>
    <PersonGivenName structures:metadata="M2">Jack</PersonGivenName>
    <PersonSurName structures:metadata="M1 M2">Smith</PersonSurName>
  </PersonName>
  <PersonBirthDate>1945-12-01</PersonBirthDate>
</Person>
<Metadata structures:id="M1"><SourceText>Adam Barber</SourceText></Metadata>
<Metadata structures:id="M2"><SourceText>Charles
Daniels</SourceText></Metadata>
```

This example shows a person. In this example, Adam Barber says the person is John Smith. Charles Daniels says his name is Jack Smith. A source for the person's birth date is not given.

This shows several characteristics of metadata:

1. Metadata objects may appear outside the data they describe
2. Metadata objects may be reused
3. Data may refer to more than one metadata object

[Rule 7-8]

Within a NIEM-conformant element instance, when an object O links to a metadata object via an attribute `structures:metadata`, the information in the metadata object SHALL be applied to the object O.

[Rule 7-9]

Within a NIEM-conformant element instance, when an object O1 contains an element E, with content object O2, and O2 links to a metadata object via an attribute `structures:linkMetadata`, the information in the metadata object SHALL be applied to the relationship E between O1 and O2.

Rationale

These two rules define the meaning of metadata:

- `structures:metadata` applies metadata to an object.
- `structures:linkMetadata` applies metadata to a relationship between two objects.

[Rule 7-10]

Within a NIEM-conformant element instance, each `IDREF` contained in the value of an attribute `structures:metadata` MUST refer to an attribute `structures:id` owned by an instance of a metadata type in the same information set.

[Rule 7-11]

Within a NIEM-conformant element instance, each IDREF contained in the value of an attribute `structures:linkMetadata` MUST refer to an attribute `structures:id` owned by an instance of a metadata type in the same information set.

Rationale

All `structures:metadata` and `structures:linkMetadata` attributes must refer to metadata objects.

[Rule 7-12]

Within a set of NIEM-conformant element instances within an information set, any metadata element instance referred to from an element instance of some type *T* MUST be applicable to an object type T.

Rationale

The applicability is determined by `structures:AppliesTo` application information of the metadata type definition. The instances must correspond to the types specified by the metadata type definition.

8. Naming Rules

This section outlines the rules used to create names for NIEM data components previously discussed in this document. Data component names must be understood easily both by humans and by machine processes. These rules improve name consistency by restricting characters, terms, and syntax that could otherwise allow too much variety and potential ambiguity. These rules also improve readability of names for humans, facilitate parsing of individual terms that compose names, and support various automated tasks associated with dictionary and controlled vocabulary maintenance.

8.1. Extension of XSD Namespace Simple Types

[Rule 8-0.9]

Within a NIEM-conformant schema, a complex type that is a direct extension of an XML Schema namespace simple type MAY use the same local name as the simple type, if and only if the extension adds no content other than the attribute group `structures:SimpleObjectAttributeGroup`.

Rationale

It is useful to build complex type bases for further extension. The NIEM distribution proxy schema `xsd.xsd` provides complex type bases for some of the simple types in the XML Schema namespace. However, the complex types in this proxy schema reuse the local names of the simple types they extend, even though the simple type names may not be NIEM-conformant. Requiring name changes for those NIEM-provided complex type bases would work against user understanding, for those already familiar with the names of the XML Schema namespace simple types being extended.

8.2. Usage of English

[Rule 8-1]

The name of any XML Schema component defined by NIEM-conformant schemas SHALL be composed of words from the English language, using the prevalent U.S. spelling, as provided by **[OED]**.

Rationale

The English language has many spelling variations for the same word. For example, American English “program” has a corresponding British spelling “programme.” This variation has the potential to cause interoperability problems when exchanging XML components because of the different names used by the same elements. Providing a dictionary standard for spelling will mitigate this potential interoperability issue.

8.3. Characters in Names

[Rule 8-2]

The name of any XML Schema component defined by a NIEM-conformant schema SHALL contain only the following characters:

- upper-case letters ('`A`'-'`Z`'),
- lower-case letters ('`a`'-'`z`'),
- digits ('`0`'-'`9`'), and
- hyphen ('`-`').

Other characters, such as the underscore ('_') character and the period ('.') character SHALL NOT appear in component names in NIEM-conformant schemas.

[Rule 8-3]

The hyphen character ('-') MAY appear in component names only when used as a separator between parts of a single word, phrase, or value, that would otherwise be incomprehensible without the use of a separator.

Rationale

Names of standards and specifications, in particular, tend to consist of series of discrete numbers. Such names require some explicit separator, to keep the values from running together. The separator used within NIEM is the hyphen.

Names of NIEM components follow the rules of XML Schema, by **[Rule 4-3]**. NIEM components also must follow the rules specified for each type of XML Schema component.

8.4. Character Case

[Rule 8-4]

Within a NIEM-conformant schema, any attribute declaration SHALL have a name that begins with a lower-case letter ('a'-'z').

[Rule 8-5]

Within a NIEM-conformant schema, any XML Schema component other than an attribute declaration SHALL have a name that begins with an upper-case letter ('A'-'Z').

Camel case is the practice of writing compound words or phrases in which the words are joined without spaces and are capitalized within the compound words. [2]

[Rule 8-6]

The name of any XML Schema component defined by a NIEM-conformant schema SHALL use the camel case formatting convention.

Rationale

The foregoing rules establish *lowerCamelCase* for all NIEM components that are XML attributes, and *UpperCamelCase* for all NIEM components that are types, elements, or groups.

8.5. Use of Acronyms and Abbreviations

Acronyms and abbreviations have the ability to improve readability and comprehensibility of large, complex, or frequently-used terms. They also obscure meaning and impair understanding when their definition is not clear, or when they are used injudiciously. They should be used with great care. Acronyms and abbreviations that are used must be documented, and used consistently.

[Rule 8-7]

A NIEM-conformant schema MUST consistently use approved acronyms, abbreviations, and word truncations within defined names. The approved shortened forms are defined in Table 2: Abbreviations used in NIEM Core Names
.

[2] Adapted from `http://en.wikipedia.org/wiki/Camel_case`

Table 2: Abbreviations used in NIEM Core Names

Abbreviation	Full Meaning
ANSI	American National Standards Institute
CMV	Commercial Motor Vehicle
DEA	Drug Enforcement Agency
DNA	Deoxyribonucleic Acid
FGI	Foreign Government Information
FIPS	Federal Information Processing Standard
IC	Intelligence Community
ID	Identifier
IP	Internet Protocol
ISO	International Standards Organization
LIS	NCIC code list for license state
LSTA	NCIC code list for state/country index
MCO	Manufacturer's Certificate of Origin
MGRS	Military Grid Reference System
MSRP	Manufacturer's Suggested Retail Price
NANP	North American Numbering Plan
NCIC	National Crime Information Center
NCTC	National Counter Terrorist Center
NIBRS	National Incident Based Reporting System
NLETS	The International Justice & Public Safety Information Sharing Network (formerly known as the National Law Enforcement Teletype System)
ORI	Organization Identifier (Orion)
RES	NCIC code list for registration state for boat registrations
RF	Radio Frequency
SIM	Subscriber Identity Module
SSN	Social Security Number
TYP	NCIC code list for gun type
TYPO	NCIC code list for ORI type
URI	Uniform Resource Identifier
US	United States
UTM	Universal Transverse Mercator
VIN	Vehicle Identification Number
VINA	Vehicle Identification Number Analysis

Rationale

Consistent, controlled, and documented abridged terms that are used frequently and/or tend to be lengthy can support readability, clarity, and reduction of name length.

8.6. Word Forms

[Rule 8-8]

A noun used as a term in a NIEM component MUST be used in singular form, unless the concept itself is plural.

[Rule 8-9]

A verb used as a term in a NIEM component MUST be used in the present tense, unless the concept itself is past tense.

[Rule 8-10]

Articles, conjunctions and prepositions SHALL NOT be used in NIEM component names, except where they are required for clarity or by standard convention (e.g.; `PowerOfAttorneyCode`).

Rationale

Articles (e.g., a, an, the), conjunctions (e.g., and, or, but), and prepositions (e.g., at, by, for, from, in, of, to) are all disallowed in NIEM component names. These rules constrain slight variations in word forms and types to improve consistency and reduce potentially ambiguous or confusing component names.

8.7. Name Generation

Elements in NIEM-conformant schemas are given names that follow a specific pattern. This pattern comes from **[ISO 11179 Part 5]**.

[Rule 8-11]

Except as specified elsewhere in this document, any element or attribute defined within a NIEM-conformant schema SHALL have a name which takes the form:

- object class qualifier terms (0 or more)
- an object class term (1)
- property qualifier terms (0 or more)
- a property term (1)
- representation qualifier terms (0 or more)
- a representation term (1).

Rationale

Consistent naming rules are helpful for users who wish to understand components with which they are unfamiliar, as well as for users to find components with known semantics. This rule establishes the basic structure for an element or attribute name, in line with the rules for names under **[ISO 11179 Part 5]**.

8.8. Object Class Term

The NIEM adopts an object-oriented approach to representation of data. Object classes represent what **[ISO 11179 Part 5]** refers to as “things of interest in a universe of discourse that may be found in a model of that universe.” An object class or object term is a word that represents a class of real-world entities or concepts. An object class term describes the applicable context for a NIEM component.

[Rule 8-12]

The object class term of a NIEM component SHALL consist of a term identifying a category of concrete concepts or entities.

Rationale

The object class term indicates the object category which this data component describes or represents. This term provides valuable context and narrows the scope of the component to an actual class of things or concepts.

Example

Concept term: Activity

Entity term: Vehicle

8.9. Property Term

Objects or concepts are usually described in terms of their characteristic properties, data attributes, or constituent subparts. Most objects can be described by several characteristics. Therefore, a property term in the name of a data component represents a characteristic or subpart of an object class, and generally describes the essence of that data component.

[Rule 8-13]

A property term SHALL describe or represent a characteristic or subpart of an entity or concept.

Rationale

The property term describes the central meaning of the data component.

8.10. Qualifier Terms

Qualifier terms modify object, property, representation, or other qualifier terms in order to increase semantic precision and reduce ambiguity. Qualifier terms may precede or succeed the terms they modify. The goal for the placement of qualifier terms is to generally follow the rules of ordinary English while maintaining clarity.

[Rule 8-14]

Multiple qualifier terms MAY be used within a component name as necessary to ensure clarity and uniqueness within its namespace and usage context.

[Rule 8-15]

The number of qualifier terms SHOULD be limited to the absolute minimum required to make the component name unique and understandable.

[Rule 8-16]

The order of qualifiers SHALL NOT be used to differentiate names.

Rationale

Very large vocabularies may have many similar and closely related properties and concepts. The use of object, property, and representation terms alone is often not sufficient to construct meaningful names that can uniquely distinguish such components. Qualifier terms provide additional context to resolve these subtleties. However, swapping the order of qualifiers rarely (if ever) changes meaning; qualifier ordering is no substitute for meaningful terms.

8.11. Representation Term

The representation term for a component name serves several purposes in NIEM:

1. It can indicate the style of component. For example, types are clearly labeled with the representation term `Type`.
2. It helps prevent name conflicts and confusion. For example, elements and types may not be given the same name.

3. It indicates the nature of the value carried by element. Labeling elements and attributes with a notional indicator of the content eases discovery and comprehension.

[Rule 8-17]

If any word in the representation term is redundant with any word in the property term, one occurrence SHOULD be deleted.

The valid value set of a data element or value domain is described by the representation term. NIEM uses a standard set of representation terms in the representation portion of a NIEM-conformant component name. Table 3: Representation Terms lists the primary representation terms and a definition for the concept associated with the use of that term. The table also lists secondary representation terms that may represent more specific uses of the concept associated with the primary representation term.

Table 3: Representation Terms

Primary Representation Term	Secondary Representation Term	Definition
Amount	-	A number of monetary units specified in a currency where the unit of currency is explicit or implied.
BinaryObject	-	A set of finite-length sequences of binary octets.
	Graphic	A diagram, graph, mathematical curves, or similar representation
	Picture	A visual representation of a person, object, or scene
	Sound	A representation for audio
	Video	A motion picture representation; may include audio encoded within
Code		A character string (letters, figures or symbols) that for brevity, language independence, or precision, represents a definitive value of an attribute.
DateTime		A particular point in the progression of time together with relevant supplementary information.
	Date	A particular day, month, and year in the Gregorian calendar.
	Time	A particular point in the progression of time within an unspecified 24 hour day.
ID		A character string to identify and distinguish uniquely, one instance of an object in an identification scheme from all other objects in the same scheme together with relevant supplementary information.

	URI	A string of characters used to identify (or name) a resource. The main purpose of this identifier is to enable interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols. A URI is either a Uniform Resource Locator (URL) or a Uniform Resource Name (URN). The specific syntax for each is defined by **[RFC3986]**.
Indicator		A list of two mutually exclusive Boolean values that express the only possible states of a property.
Measure		A numeric value determined by measuring an object along with the specified unit of measure.
Numeric		Numeric information that is assigned or is determined by calculation, counting, or sequencing. It does not require a unit of quantity or unit of measure.
	Value	A result of a calculation
	Rate	A representation of a ratio where the two units are not included.
	Percent	A representation of a ratio in which the two units are the same.
Quantity		A counted number of non-monetary units possibly including fractions.
Text	-	A character string (i.e. a finite sequence of characters) generally in the form of words of a language.
	Name	A word or phrase that constitutes the distinctive designation of a person, place, thing or concept.

[Rule 8-18]

Within a NIEM-conformant schema, the name of an element declaration that is of simple content MUST use a representation term found in Table 3: Representation Terms.

[Rule 8-19]

Within a NIEM-conformant schema, the name of an element declaration that is of complex content, and which corresponds to a concept listed in Table 3: Representation Terms, MUST use a representation term from that table.

[Rule 8-20]

Within a NIEM-conformant schema, the name of an element declaration which is of complex content and which does not correspond to a concept listed in Table 3: Representation Terms, MUST NOT use a representation term from that table.

[Rule 8-21]

Within a NIEM-conformant schema, the name of an attribute declaration MUST use a representation term from Table 3: Representation Terms.

Rationale

An element which represents a value listed in the table should have a representation term. It should do so even if its type is complex with multiple parts. For example, a type with multiple fields may represent a sound binary, or a date, or a name.

8.12. NIEM Type Names

This section contains naming rules specific to various kinds of NIEM types.

8.12.1. All Type Components

[Rule 8-22]

Within a NIEM-conformant schema, the name of any type definition MUST use the representation term `Type`.

Rationale

Using the representation term `Type` immediately identifies XML types in a NIEM-conformant schema and prevents naming collisions with corresponding XML elements and attributes.

8.12.2. Simple Type Components

[Rule 8-23]

Within a NIEM-conformant schema, the name of any simple type definition SHALL use the representation term qualifier `Simple`. This qualifier SHALL appear after any other representation term qualifiers.

Rationale

Specific uses of type definitions have similar syntax, but very different effects on data definitions. Schemas that clearly identify complex and simple type definitions are easier to understand without tool support. This rule ensures that names of simple types end in `SimpleType`.

8.12.3. Code Type Components

[Definition: code type]

A **code type** is a simple type schema component definition which contains multiple `xsd:enumeration` facets.

These types represent lists of values, each of which has a known meaning beyond the text representation. These values may be meaningful text or may be a string of alphanumeric identifiers which represent abbreviations for literals.

[Rule 8-24]

Within a NIEM-conformant schema, the name of any code type SHALL use the representation term qualifier `Code`.

Rationale

Using the qualifier `Code` (i.e. `CodeType, CodeSimpleType`) immediately identifies a type as representing a fixed list of codes. These types may be handled in specific ways, as lists of codes are expected to have their own lifecycles, including versions and periodic updates. Codes may also have responsible authorities behind them, who provide concrete semantic bindings for the code values.

[Rule 8-25]

Within a NIEM-conformant schema, any type definition which has a base type definition of a code type or which is transitively based on a code type SHALL have a name which uses the representation term qualifier `Code`.

Rationale

This expands the use of the representation term qualifier `Code` to any type based on a code list.

8.12.4. Association Type Components

[Rule 8-26]

Within a NIEM-conformant schema, any association type SHALL have a name that uses the representation term qualifier `Association`. Types other than association types SHALL NOT use the representation term qualifier `Association`.

Rationale

Using the qualifier `Association` immediately identifies a type as representing an association.

8.12.5. Augmentation Type Components

[Rule 8-27]

Within a NIEM-conformant schema, any augmentation type SHALL have a name that uses the representation term qualifier `Augmentation`. Types other than augmentation types SHALL NOT use the representation term qualifier `Augmentation`.

Rationale

Using the qualifier `Augmentation` immediately identifies a type as representing an augmentation.

8.12.6. Metadata Type Components

[Rule 8-28]

Within a NIEM-conformant schema, any metadata type SHALL have a name that uses the representation term qualifier `Metadata`. Types other than metadata types SHALL NOT use the representation term qualifier `Metadata`.

Rationale

Using the qualifier `Metadata` immediately identifies a type as representing metadata.

8.13. NIEM Property Names

This section contains naming rules specific to different kinds of NIEM properties.

8.13.1. Attribute Group Names

[Rule 8-29]

Within a NIEM-conformant schema, the name of any attribute group definition schema component SHALL use the representation term `AttributeGroup`.

Rationale

This clearly identifies attribute groups, and partitions their names from the names of other types of schema components.

8.13.2. Reference Names

[Rule 8-30]

Within a NIEM-conformant schema, the name of any reference element SHALL use the representation term suffix `Reference`.

Rationale

Reference elements are identical in semantics to elements that are not by-reference. However, they refer to their values by a reference attribute, instead of carrying it as content of the XML element. The use of a suffix helps indicate that the elements refer to, instead of contain, their values, yet allows the basic semantics (e.g. property, representation term) to persist.

Note that the use of the representation term suffix is one of the situations in which there is a slight divergence from the general rule for name generation as discussed in **[Rule 8-11]**.

8.13.3. Association Names

[Rule 8-31]

Within a NIEM-conformant schema, the name of an association element SHALL use the representation term qualifier `Association.`

Rationale

Using the qualifier `Association` immediately identifies an element as representing an association.

8.13.4. Augmentation Names

[Rule 8-32]

Within a NIEM-conformant schema, the name of an augmentation element SHALL use the representation term `Augmentation`.

Rationale

Using the qualifier `Augmentation` immediately identifies an element as representing an augmentation.

8.13.5. Metadata Names

[Rule 8-33]

Within a NIEM-conformant schema, the name of a metadata element SHALL use the representation term `Metadata`.

Rationale

Using the qualifier `Metadata` immediately identifies an element as representing metadata.

8.13.6. Role Names

[Rule 8-34]

Within a NIEM-conformant schema, the name of a role SHALL use the property term `RoleOf`.

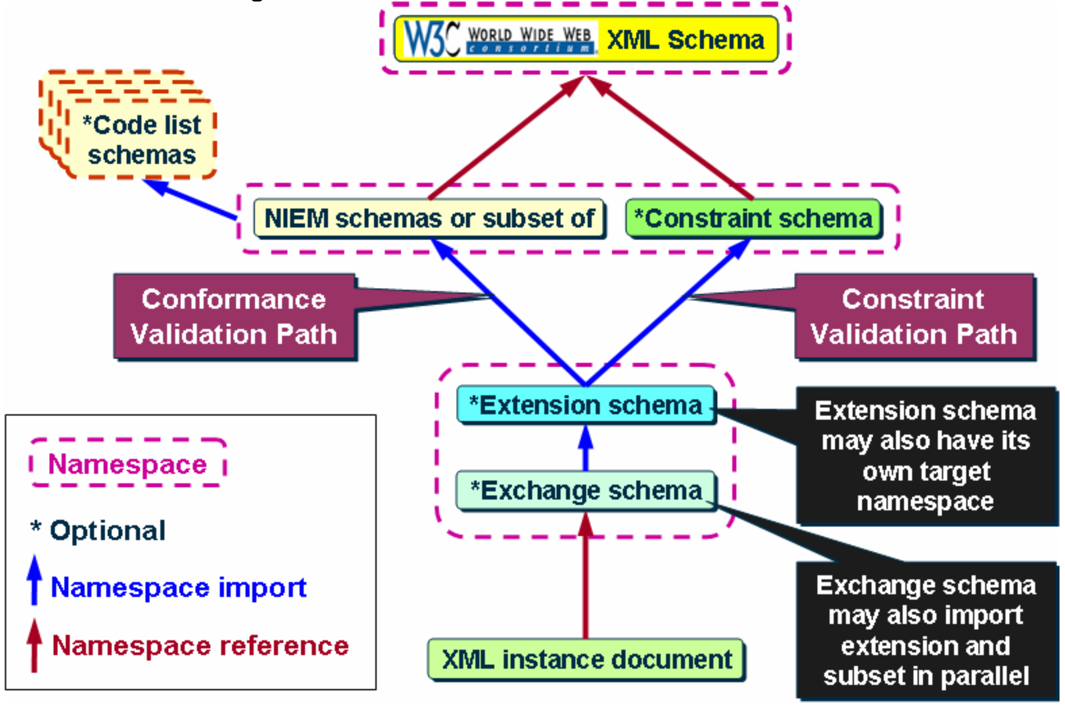
Rationale

Using the property term `RoleOf` immediately identifies an element as representing a role.

Appendix A. NIEM Overview

The NIEM is a reference model of unconstrained components rendered in XML Schema. Associated with the NIEM schemas is an XML reference architecture that organizes and guides the employment of the various kinds of schemas that compose a NIEM information exchange. The XML reference architecture describes the relationships between XML schemas for NIEM Information Exchange Package Documentation (IEPD).

Figure 1: The NIEM XML Reference Architecture


W3C WORLD WIDE WEB consortium XML Schema
*Code list schemas
NIEM schemas or subset of
*Constraint schema
Conformance Validation Path
Constraint Validation Path
*Extension schema
*Exchange schema
Extension schema may also have its own target namespace
Exchange schema may also import extension and subset in parallel
XML instance document
Namespace
* Optional
Namespace import
Namespace reference

A NIEM IEPD is a set of artifacts that describe an Information Exchange Package (IEP), a standard message structure as defined by the Federal Enterprise Architecture Consolidated Reference Model Document **[CRM]**. The NIEM IEPD Specification **[IEPD]** contains a more detailed explanation of IEPDs and their contents.

The following kinds of XML schemas are associated with the NIEM reference architecture

- NIEM reference schemas: Schemas containing content created or approved by the NIEM steering committees are periodically released in schema distributions. The structure and content of such distributions are not specified in this document. This document specifies rules that apply to the NIEM-conformant schemas that are released as part of such distributions.
- NIEM support schemas: NIEM includes two special schemas, the `appinfo` and the `structures` schemas, for annotating and structuring NIEM-conformant schemas.
- Extension Schema: a NIEM-conformant schema which adds domain- or application-specific content to the base NIEM model.
- Exchange Schema: a NIEM-conformant schema which specifies a document in a particular exchange.
- Subset Schema: a profile of a NIEM-conformant schema, derived from a reference schema, but which specifies instances that only require a portion of the reference schema.

- Constraint Schema: a schema which adds additional constraints to NIEM-conformant instances, but which is assumed to validate in concert with existing NIEM-conformant or subset schemas. A constraint schema need not validate constraints that are applied by other schemas.

The only mandatory schemas for validation are the NIEM reference schemas or correct subsets. The NIEM schemas may import additional schemas, such as code table schemas, as needed. The optional exchange schema imports, re-uses, and organizes the components from the NIEM for the particular exchange. An optional extension schema may be used to add extended types and properties for components not contained in the NIEM, but which are needed for the exchange.

Note that while only the reference schemas, or subsets thereof, are required for validation of a NIEM-conformant instance. The IEPD specification requires that an IEPD include an exchange schema along with the reference schemas (or subsets) to be considered a complete IEPD.

The exchange and extension schemas can be combined into a single schema and namespace, or can be broken out into separate schemas and corresponding namespaces. The user may decide the best way to organize components. If the extension components will be reused elsewhere, it may be more efficient to maintain them in a separate namespace, rather than including them in a document namespace.

The NIEM reference schemas are over-inclusive and under-constrained. The reason for this approach is that pre-determining all user needs and constraints is rarely possible. The only way to reach consensus on components is to include all obvious requirements and maintain relatively relaxed constraints.

To ensure interoperability, specific component requirements and constraints are determined on a per-exchange basis (in IEPDs). By creating a subset of NIEM Core, reference and code table schemas, the user can limit the components to only those he or she needs. In the future, a business component layer between IEPDs and NIEM will allow domains to apply consistent requirements and constraints for their exchanges.

The basic principle for a subset is that an instance that validates against a correct subset schema will always validate against the full reference NIEM schema set. The user may also adjust cardinality constraints, as desired, within the subset schemas.

Additional constraints may be handled in a constraint schema. A constraint schema is derived from a subset schema. However, it may contain other constraints (for example, additional types for specific constraints). The constraint schema provides an alternative *constraint validation* path that allows the user to reduce the possible set of allowable XML instances, independent of the NIEM schema or subset *conformance validation* path. This is done through multi-pass validation. A correctly constructed XML instance will validate through both the conformance and the constraint path.

Appendix B. NIEM Design Principles

This appendix summarizes all the underlying NIEM design principles discussed in Section 3, Guiding Principles.

[Principle 1]

This specification should specify what is necessary for interoperability, and no more.

[Principle 2]

This specification should focus on providing rules for specifying schemas.

[Principle 3]

This specification should feature rules which are as specific, precise, and concise as possible.

[Principle 4]

The content of a NIEM-conformant data instance should not be modified by processing against XML schemas.

[Principle 5]

NIEM should depend on XML Schema validating parsers for validation of XML content.

[Principle 6]

The primary purpose of XML Schema validation is to restrict processed data to that data that conforms to agreed-upon rules. This restriction is achieved by marking as invalid that data that does not conform to the rules defined by the schema.

[Principle 7]

Constraints on XML instances MAY be validated by multiple schema validation passes, using multiple schemas for a single namespace.

[Principle 8]

Each NIEM-conformant namespace will be defined by exactly one reference schema.

[Principle 9]

NIEM-conformant schemas do not specify data that uses mixed content.

[Principle 10]

Using named global components in schemas maximizes the capacity for reuse.

[Principle 11]

Wildcards in standard schemas should be avoided.

[Principle 12]

Schema locations specified within NIEM-conformant reference schemas are hints and provide default values to processing applications.

[Principle 13]

NIEM-conformant instances and schemas should reuse components from NIEM distribution schemas when possible.

[Principle 14]

A namespace is a required part of the name of a component. A component's local name is considered independent of, and unassociated with, names from other namespaces.

[Principle 15]

NIEM is intended for extension and augmentation by users and developers outside the standardization process.

[Principle 16]

XML data is primarily intended for automatic processing, not for literal presentation to people.

[Principle 17]

NIEM should not depend on specific software packages, frameworks, or systems for interpretation of XML instances.

[Principle 18]

NIEM should be implemented with a variety of commercial off-the-shelf and free software products.

[Principle 19]

A data component definition should be drafted before the associated data element name is composed.

[Principle 20]

Components in NIEM should be given names which are consistent with names of other NIEM components. Such names should be based on simple rules.

Appendix C. NIEM Rules

This listing of rules is informative only. For reference purposes, it summarizes all the rules found in this document.

[Rule 4-1]

A NIEM-conformant schema MUST conform to XML as specified by **[XML]**

[Rule 4-2]

A NIEM-conformant schema MUST conform to the specification for namespaces in XML, as defined by **[XMLNamespaces]** and **[XMLNamespacesErrata]**.

[Rule 4-3]

A NIEM-conformant schema MUST conform to the W3C XML Schema Recommendations: XML Schema Part 1: Structures and XML Schema Part 2: Datatypes, as specified by **[XMLSchemaStructures]** and **[XMLSchemaDatatypes]**.

[Rule 4-4]

Within a NIEM-conformant schema, the text definition provided for each documented component SHALL follow the requirements and recommendations for data definitions given by **[ISO 11179 Part 4]**.

[Rule 4-5]

In general, a NIEM component name SHALL be formed by applying the informative guidelines and examples detailed in Annex A of **[ISO 11179 Part 5]**, with exceptions as specified in this document, most notably those specified in Section 8, Naming Rules.

[Rule 5-1]

Within a NIEM-conformant schema, an element `xsd:complexType` SHALL NOT own the attribute mixed with the value true.

[Rule 5-2]

Within a NIEM-conformant schema, an element declaration which is of complex content SHALL NOT own the attribute `mixed` with the value `true`.

[Rule 5-3]

A NIEM-conformant schema SHALL NOT contain a reference to the type definition `xsd:NOTATION`, or to a type derived from that type.

[Rule 5-4]

A NIEM-conformant schema SHALL NOT contain the element `xsd:notation`.

[Rule 5-5]

A NIEM-conformant schema SHALL NOT contain the element `xsd:include`.

[Rule 5-6]

A NIEM-conformant schema SHALL NOT contain the element `xsd:redefine`.

[Rule 5-7]

A NIEM-conformant schema SHALL NOT reference the type `xsd:anyType`.

[Rule 5-8]

A NIEM-conformant schema SHALL NOT reference the type `xsd:anySimpleType`.

[Rule 5-9]

Within a NIEM-conformant schema, an element declaration with the attribute `name` and without the attribute `type` MUST carry the attribute `abstract` with the value `true`.

[Rule 5-10]

Within a NIEM-conformant schema, an attribute declaration with attribute `name` MUST carry the attribute `type`.

[Rule 5-11]

A NIEM-conformant schema SHALL NOT contain the element `xsd:any`.

[Rule 5-12]

A NIEM-conformant schema SHALL NOT contain the element `xsd:anyAttribute`.

[Rule 5-13]

Within a NIEM-conformant schema, any type definition MUST appear as an immediate child of the document element `xsd:schema`.

[Rule 5-14]

Within a NIEM-conformant schema, any element declaration carrying the attribute `name` MUST appear as an immediate child of the document element `xsd:schema`.

[Rule 5-15]

Within a NIEM-conformant schema, any attribute declaration owning the attribute `name` MUST appear as an immediate child of the document element `xsd:schema`.

[Rule 5-16]

A NIEM-conformant schema SHALL NOT contain any of the elements `xsd:unique`, `xsd:key`, `xsd:keyref`, `xsd:selector`, or `xsd:field`.

[Rule 5-17]

A NIEM-conformant schema SHALL NOT contain the element `xsd:all` or the element `xsd:choice`.

[Rule 5-18]

Within a NIEM-conformant schema, any immediate child of a model group `xsd:sequence` element MUST be one of `xsd:annotation`, or `xsd:element`.

[Rule 5-19]

A NIEM-conformant schema SHALL NOT contain the element `xsd:group`.

[Rule 5-20]

Within a NIEM-conformant schema, if the element `xsd:sequence` carries the attribute `minOccurs`, it MUST set the value for the attribute to `1`.

[Rule 5-21]

Within a NIEM-conformant schema, if the element `xsd:sequence` carries the attribute `maxOccurs`, it MUST set the value of the attribute to `1`.

[Rule 5-22]

Within a NIEM-conformant schema, if an element declaration carries the attribute `block`, it MUST set the value for the attribute to the empty string.

[Rule 5-23]

Within a NIEM-conformant schema, if a complex type definition carries the attribute `block,` it MUST set the value for the attribute to the empty string.

[Rule 5-24]

Within a NIEM-conformant schema, if the document element `xsd:schema` carries the attribute `blockDefault`, it MUST set the value for the attribute to the empty string.

[Rule 5-25]

Within a NIEM-conformant schema, if a simple type definition carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-26]

Within a NIEM-conformant schema, if a complex type definition carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-27]

Within a NIEM-conformant schema, if an element declaration carries the attribute `final`, it MUST set the value for the attribute to the empty string.

[Rule 5-28]

Within a NIEM-conformant schema, if the document element `xsd:schema` carries the attribute `finalDefault`, it MUST set the value for that attribute to the empty string.

[Rule 5-29]

Within a NIEM-conformant schema, any element `xsd:element` SHALL NOT carry the attribute `default`.

[Rule 5-30]

Within a NIEM-conformant schema, any element `xsd:attribute` SHALL NOT carry the attribute `default`.

[Rule 5-31]

A NIEM-conformant schema SHALL NOT contain the element `xsd:list`.

[Rule 5-32]

A NIEM-conformant schema SHALL NOT contain the element `xsd:union.`

[Rule 5-33]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST carry the attribute `targetNamespace`.

[Rule 5-34]

The value of the required attribute `targetNamespace` on the document element `xsd:schema` MUST match the production `<absolute-URI>` as defined by **[RFC3986]**.

[Rule 5-35]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST carry the attribute `version`.

[Rule 5-36]

The value of the required attribute `version` on the document element `xsd:schema` MUST NOT be an empty string.

[Rule 5-37]

Within a NIEM-conformant schema, the element `xsd:import` MUST carry the attribute `namespace`.

[Rule 5-38]

The value of the required attribute `namespace` carried by the element `xsd:import` MUST match the production `<absolute-URI>` as defined by **[RFC3986]**.

[Rule 5-39]

Within a NIEM-conformant schema, the element `xsd:import` MUST carry the attribute `schemaLocation`.

[Rule 5-41]

Within a NIEM-conformant schema, the value of the required attribute `schemaLocation` carried by the element `xsd:import` MUST match either the production `<absolute-URI>`, or the definition of "*relative-path reference*", as defined by **[RFC3986]**.

[Rule 5-42]

Within a NIEM-conformant schema, the value of the required attribute `schemaLocation` carried by the element `xsd:import` MUST be resolvable to a XML schema document file that is valid according to **[XMLSchemaStructures]** and **[XMLSchemaDatatypes]**.

[Rule 5-43]

Within a NIEM-conformant schema, when a namespace other than the XML namespace or the XML Schema namespace is used, it MUST be imported into the schema using the `xsd:import` element.

[Rule 5-44]

Within a NIEM-conformant schema, when a namespace other than the XML namespace or the XML Schema namespace is used, its content MUST be valid with respect to the schema imported for that namespace.

[Rule 5-45]

Within a NIEM-conformant schema, an element SHALL have at most one instance of an element `xsd:annotation` as an immediate child.

[Rule 5-46]

Within a NIEM-conformant schema, the content of an `xsd:documentation` element MUST be character information items as specified by **[XMLInfoSet]**.

[Rule 5-47]

Within a NIEM-conformant schema, the element `xsd:annotation` MUST have at most one instance of the element `xsd:documentation` as an immediate child.

[Rule 5-48]

XML comments SHALL not be used for persistent information about constructs within XML Schemas.

[Rule 5-49]

Within a NIEM-conformant schema, any immediate child of an `xsd:appinfo` element SHALL be an element information item, or a comment information item.

[Rule 5-50]

Within a NIEM-conformant schema, any element that is an immediate child of an `xsd:appinfo` element SHALL be in a namespace.

[Rule 5-50.1]

Within a NIEM-conformant schema, an element in the XML Schema namespace MUST NOT occur as a descendant of any element `xsd:appinfo`.

[Rule 5-51]

Within NIEM-conformant schemas, the element `xsd:simpleType` MUST have the element `xsd:restriction` as an immediate child.

[Rule 5-52]

Within a NIEM-conformant schema, the element `xsd:complexType` MUST have as an immediate child either the element `xsd:complexContent` or the element `xsd:simpleContent`.

[Rule 5-53]

Within a NIEM-conformant schema, the element `xsd:simpleContent` MUST have as an immediate child the element `xsd:extension`.

[Rule 5-54]

Within a NIEM-conformant schema, given an element `xsd:simpleContent` with a child `xsd:extension` owning an attribute `base`, if the attribute `base` has a value that resolves to the name of a simple type, then the element `xsd:extension` MUST have an immediate child element `xsd:attributeGroup`.

[Rule 5-55]

Within a NIEM-conformant schema, the element `xsd:complexContent` MUST have as an immediate child the element `xsd:extension`.

[Rule 5-56]

Within a NIEM-conformant schema, given an element `xsd:complexContent` with a child `xsd:extension` owning an attribute `base`, the attribute `base` MUST have a value that resolves to the name of one of

1. the type `structures:ComplexObjectType`, or
2. the type `structures:MetadataType`, or
3. the type `structures:AugmentationType`, or
4. a NIEM-conformant complex type.

[Rule 5-57]

Within a NIEM-conformant schema, any occurrence of the element `xsd:attributeGroup` MUST own an attribute `ref`.

[Rule 5-58]

Within a NIEM-conformant schema, the attribute `ref` owned by any element `xsd:attributeGroup` MUST have a value of a qualified name (possibly using the default namespace) that SHALL resolve to the namespace for the NIEM `structures` namespace and the local name `SimpleObjectAttributeGroup`.

[Rule 6-1]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST have application information `appinfo:ConformantIndicator`, with text content "`true`".

[Rule 6-2]

Two XML schemas SHALL have the same value for attribute `targetNamespace` carried by the element `xsd:schema` if and only if they represent the same set of components.

[Rule 6-3]

Two XML Schemas SHALL have the same value for attribute `targetNamespace` carried by the element `xsd:schema`, and different values for attribute `version` carried by the element `xsd:schema` if and only if they are different views of the same set of components.

[Rule 6-4]

Within a NIEM-conformant schema, any type definition MUST be a documented component.

[Rule 6-5]

Within a NIEM-conformant schema, any element declaration MUST be a documented component.

[Rule 6-6]

Within a NIEM-conformant schema, any attribute declaration MUST be a documented component.

[Rule 6-7]

Within a NIEM-conformant schema, the element `xsd:enumeration` MUST be a documented component.

[Rule 6-8]

Within a NIEM-conformant schema, the document element `xsd:schema` MUST be a documented component.

[Rule 6-9]

Words or synonyms for the words within a data element definition MAY be reused as terms in the corresponding component name, if those words do not dilute the semantics and understanding of, or impart ambiguity to, the entity or concept that the component represents.

[Rule 6-10]

An object class SHALL have one and only one associated semantic meaning (i.e. a single word sense.) as described in the definition of the component that represents that object class.

[Rule 6-11]

An object class SHALL NOT be redefined within the definitions of the components that represent properties or subparts of that entity or class.

[Rule 6-12]

A NIEM data definition SHALL NOT contain explicit representational or data typing information such as number characters, type of characters, etc., unless the very nature of the component can only be described by such information.

[Rule 6-13]

A component definition SHALL begin with a standard opening phrase that depends on the class of the component per Table 1: Standard Opening Phrases:

[Rule 6-14]

A NIEM-conformant schema SHALL import the `appinfo` namespace.

[Rule 6-15]

A component which is deprecated SHALL be indicated as such by the component having application information `appinfo:Deprecated`, with an attribute `value` with a value of `true`.

[Rule 6-16]

Within a NIEM-conformant schema, the element `appinfo:Base` MAY be used in one of the following ways:

1. By a type definition, to indicate the base type, or `structures:Object` or `structures:Association`, or
2. By an element declaration, to indicate the base element

The element `appinfo:Base` SHALL NOT be used for any other purpose.

[Rule 6-17]

Within a NIEM-conformant schema, the element `appinfo:Base` SHALL indicate, by namespace and name, one of the following:

1. a NIEM-conformant schema component, or
2. `structures:Object`, or
3. `structures:Association`.

[Rule 6-18]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` owned by an element `appinfo:Base` SHALL have a value of either:

1. a namespace which is the target namespace of a NIEM-conformant schema, or
2. the `structures` namespace.

[Rule 6-19]

Within a NIEM-conformant schema, an element `appinfo:Base` which does not own an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-20]

Within a NIEM-conformant schema, an element `appinfo:Base` SHALL own an attribute `appinfo:name`.

[Rule 6-21]

Within a NIEM-conformant schema, if an element `appinfo:Base` indicates a NIEM-conformant namespace, then the value of the attribute `appinfo:name` owned by the element `appinfo:Base` SHALL indicate a schema component in the indicated namespace.

[Rule 6-22]

Within a NIEM-conformant schema, if an element `appinfo:Base` indicates the structures namespace, then the value of the attribute `appinfo:name` owned by the element `appinfo:Base` SHALL have a value of one of:

1. `structures:Object`, or
2. `structures:Association`, or
3. a schema component defined by the `structures` schema.

[Rule 6-23]

Within a NIEM-conformant schema, the element `appinfo:AppliesTo` MAY be used in any of the following ways:

1. To indicate a base type to which an augmentation may be applied
2. To indicate a base type to which a metadata type may be applied

The element `appinfo:AppliesTo` SHALL NOT be used for any other purpose.

[Rule 6-24]

Within a NIEM-conformant schema, the element `appinfo:AppliesTo` SHALL indicate a schema component, by namespace and name.

[Rule 6-25]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` owned by an element `appinfo:AppliesTo` SHALL indicate the namespace of the type to which `appinfo:AppliesTo` refers. The indicated namespace SHALL be NIEM-conformant.

[Rule 6-26]

The type to which the attribute `appinfo:appliesTo` refers MUST be the indicated type or MUST be transitively derived from the indicated type.

[Rule 6-27]

Within a NIEM-conformant schema, an element `appinfo:AppliesTo` which does not carry an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-28]

Within a NIEM-conformant schema, an element `appinfo:AppliesTo` SHALL carry an attribute `appinfo:name`. The value of this attribute SHALL indicate the local name of a schema component within the namespace specified by the element.

[Rule 6-29]

Within a NIEM-conformant schema, the element `appinfo:ReferenceTarget` SHALL specify the type of a schema component which an instance of a reference element references. The element `appinfo:ReferenceTarget` SHALL NOT be used for any other purpose.

[Rule 6-30]

A reference element SHALL reference an instance of the indicated type, or an instance of a type derived from that type.

[Rule 6-30.1]

Within a NIEM-conformant schema, a reference element MUST have at most one instance of the element `appinfo:ReferenceTarget.`

[Rule 6-31]

Within a NIEM-conformant schema, the element `appinfo:ReferenceTarget` SHALL indicate a type definition schema component, by namespace and name.

[Rule 6-32]

Within a NIEM-conformation schema, an attribute `appinfo:namespace` carried by an element `appinfo:ReferenceTarget` SHALL indicate the namespace of the referenced schema component. The indicated namespace SHALL be NIEM-conformant.

[Rule 6-33]

Within a NIEM-conformant schema, an element `appinfo:ReferenceTarget` which does not carry an attribute `appinfo:namespace` SHALL refer to the target namespace of the schema in which it is used.

[Rule 6-34]

Within a NIEM-conformant schema, an element `appinfo:ReferenceTarget` SHALL carry an attribute `appinfo:name`. The value of this attribute SHALL indicate the local name of a type definition schema component within the namespace specified by the element.

[Rule 6-35]

Within a NIEM-conformant schema, a complex type definition SHALL be one of the following classes of types:

1. An object type
2. A role type
3. An association type
4. A metadata type
5. An augmentation type
6. An adapter type.

[Rule 6-36]

Within a NIEM-conformant schema, an element MUST NOT be introduced more than once into the direct content of a type definition. This applies to content acquired through extension of base types. This does not apply to a base element or derived element to one previously existing in the type definition.

[Rule 6-37]

Within a NIEM-conformant schema, an object type SHALL be a complex type definition that has one of the following forms:

1. Has simple content, is based on a simple type, and contains the attribute group `structures:SimpleObjectAttributeGroup`, and has application information `appinfo:Base` of `structures:Object`, or
2. Has complex content, and is based on complex type `structures:ComplexObjectType`, and has application information `appinfo:Base` of `structures:Object`, or
3. Is a complex type that is derived from an object type, which is defined according to this rule.

[Rule 6-38]

Within a NIEM-conformant schema, any element with a name beginning with the string `RoleOf` SHALL represent a base type, of which the containing type represents a role.

[Rule 6-39]

Within a NIEM-conformant schema, an association type SHALL be a complex type definition that has one of the following forms:

1. Has complex content, is based on the complex type `structures:ComplexObjectType`, and has application information `appinfo:Base` of `structures:Association`, or
2. Is a complex type that is derived from an association type, which is defined according to this rule.

[Rule 6-40]

Within a NIEM-conformant schema, in an association type, any element which represents a participant in the relationship established by the association type SHALL be a reference element.

[Rule 6-41]

Within a NIEM-conformant schema, a metadata type SHALL contain elements appropriate for a specific class of data about data.

[Rule 6-42]

Within a NIEM-conformant schema, a metadata type and only a metadata type SHALL be derived directly from `structures:MetadataType`.

[Rule 6-43]

Within a NIEM-conformant schema, a metadata type MAY have application information `appinfo:AppliesTo`, indicating the NIEM-conformant object, association, or external adapter types to which the metadata applies.

[Rule 6-44]

Within a NIEM-conformant schema, a metadata type which does not have application information `appinfo:AppliesTo` MAY be applied to any object type, association type, or external adapter type.

[Rule 6-45]

An augmentation type:

1. SHALL be transitively derived from `structures:AugmentationType` and
2. SHALL contain elements which represent properties to be applied to a base type.

[Rule 6-46]

Within a NIEM-conformant schema, an augmentation element definition:

1. SHALL have a type which is an augmentation type
2. SHALL use the `substitutionGroup` attribute such that it is transitively substitutable for the element `structures:Augmentation`

An element which is not an augmentation element SHALL NOT meet either of the above criteria.

[Rule 6-47]

Within a NIEM-conformant schema, an element definition for an augmentation element MAY contain one or more instances of the element `structures:AppliesTo` as application information, to specify types to which the augmentation element applies.

[Rule 6-48]

Within a NIEM-conformant schema, an element definition for an augmentation element which does not contain any instances of the element `structures:AppliesTo` MAY be applied to any object or association type.

[Rule 6-49]

Any type definition referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The XML Schema namespace
4. The `structures` namespace.

[Rule 6-50]

Any element declaration referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The `structures` namespace
4. An external namespace, in accordance with the rules for external schemas as specified by this specification.

[Rule 6-51]

Any attribute declaration referenced by a component within a NIEM-conformant schema MUST be from one of the following:

1. The schema being defined
2. A namespace imported as NIEM-conformant
3. The `structures` namespace
4. The XML namespace

5. An external namespace, in accordance with the rules for external schemas as specified by this specification.

[Rule 6-52]

A NIEM-conformant schema MUST import the NIEM `structures` namespace.

[Rule 6-53]

NIEM-conformant schemas and instances MUST use content within the NIEM structures namespace as specified in this document and ONLY as specified by this document.

[Rule 6-54]

Within a NIEM-conformant schema, a complex type definition SHALL include the attribute `structures:sequenceID` if the order of an occurrence of the type, within its parent, relative to its siblings, is meaningful and pertinent, and if the content presented by all instances defined by the schema will not otherwise occur in the desired sequential order.

[Rule 6-55]

Within a NIEM-conformant schema, a reference element and only a reference element SHALL be defined to be of type `structures:ReferenceType`.

[Rule 6-56]

Within a NIEM-conformant schema, a complex type SHALL NOT be defined such that an instance of that type owns the attribute `structures:ref`.

[Rule 6-57]

Within a NIEM-conformant schema, any two elements of the form

NCName

and

NCName`Reference`

where the string value of *NCName* is the same in both forms, SHALL be defined to have identical semantics. The NIEM recognizes no difference in meaning between a reference element and an element that is not a reference element.

[Rule 6-58]

Within a NIEM-conformant schema, if both elements *NCName* and *NCName*`Reference` exist, then the `appinfo:ReferenceTarget` of any *NCName*`Reference` element MUST be the type of the element *NCName*.

[Rule 6-59]

Within a NIEM-conformant schema, an element `xsd:import` that imports a namespace defined by an external schema MUST have the application information `appinfo:ConformantIndicator`, with a value of `false`.

[Rule 6-60]

Within a NIEM-conformant schema, an element `xsd:import` that imports a namespace defined by an external schema MUST be a documented component.

[Rule 6-61]

Within a NIEM-conformant schema, an adapter type MUST have application information `appinfo:ExternalAdapterTypeIndicator` with a value of `true`. A type that is not an adapter type SHALL NOT contain that indicator.

[Rule 6-62]

Within a NIEM-conformant schema, an adapter type MUST be a immediate extension of type `structures:ComplexObjectType`.

[Rule 6-63]

Within a NIEM-conformant schema, an adapter type MUST be composed of only elements and attributes from an external standard.

[Rule 6-64]

Within a NIEM-conformant schema, an element reference used in an adapter type definition MUST be a documented component.

[Rule 6-65]

Within a NIEM-conformant schema, an attribute reference used in an adapter type definition MUST be a documented component.

[Rule 6-66]

Within a NIEM-conformant schema, an adapter type MUST NOT be extended or restricted.

[Rule 7-1]

A NIEM-conformant instance MUST validate to an authoritative NIEM-conformant schema set for namespaces contained in the instance, and for additional namespaces required for validation.

[Rule 7-2]

Within a NIEM-conformant instance, the meaning of an element with no content is that additional properties are not asserted. There SHALL NOT be additional meaning interpreted for an element with no content.

[Rule 7-3]

Within a NIEM-conformant element instance, there SHALL NOT be any difference in meaning between a property asserted via element containment and a property asserted by element reference, except as explicitly described by the semantics of the elements involved.

[Rule 7-4]

Any attribute `structures:ref` MUST have a value which occurs as the value of an attribute `structures:id` within the same information set.

[Rule 7-5]

Within a NIEM-conformant element instance, given that a reference element is restricted to a set S of target types T_i, S = { T_1, T_2, ..., T_n}, any attribute `structures:ref` MUST indicate the value of an attribute `structures:id` which is owned by an element of a type T such that T is, or is derived from, some type T_i in S.

[Rule 7-6]

The order of elements that are children of a NIEM-conformant element SHALL be presented as if their sequential order is as follows:

1. First, elements owning an attribute `structures:sequenceID`, in the order that would be yielded with their sequence IDs sorted via XSLT's `sort` element, with a data type of `number` and an order of `ascending`.

2. Following those elements, the remaining elements, in the order in which they occur within the XML instance.

[Rule 7-7]

Within a NIEM-conformant schema or instance, the attribute `structures:sequenceID` SHALL NOT be interpreted as meaningful beyond an indicator of sequential order of an object relative to its siblings.

[Rule 7-8]

Within a NIEM-conformant element instance, when an object O links to a metadata object via an attribute `structures:metadata`, the information in the metadata object SHALL be applied to the object O.

[Rule 7-9]

Within a NIEM-conformant element instance, when an object O1 contains an element E, with content object O2, and O2 links to a metadata object via an attribute `structures:linkMetadata`, the information in the metadata object SHALL be applied to the relationship E between O1 and O2.

[Rule 7-10]

Within a NIEM-conformant element instance, each `IDREF` contained in the value of an attribute `structures:metadata` MUST refer to an attribute `structures:id` owned by an instance of a metadata type in the same information set.

[Rule 7-11]

Within a NIEM-conformant element instance, each IDREF contained in the value of an attribute `structures:linkMetadata` MUST refer to an attribute `structures:id` owned by an instance of a metadata type in the same information set.

[Rule 7-12]

Within a set of NIEM-conformant element instances within an information set, any metadata element instance referred to from an element instance of some type *T* MUST be applicable to an object type T.

[Rule 8-0.9]

Within a NIEM-conformant schema, a complex type that is a direct extension of an XML Schema namespace simple type MAY use the same local name as the simple type, if and only if the extension adds no content other than the attribute group `structures:SimpleObjectAttributeGroup.`

[Rule 8-1]

The name of any XML Schema component defined by NIEM-conformant schemas SHALL be composed of words from the English language, using the prevalent U.S. spelling, as provided by **[OED]**.

[Rule 8-2]

The name of any XML Schema component defined by a NIEM-conformant schema SHALL contain only the following characters:

- upper-case letters ('`A`'-'`Z`'),
- lower-case letters ('`a`'-'`z`'),
- digits ('`0`'-'`9`'), and
- hyphen ('`-`').

Other characters, such as the underscore ('`_`') character and the period ('`.`') character SHALL NOT appear in component names in NIEM-conformant schemas.

[Rule 8-3]

The hyphen character ('-') MAY appear in component names only when used as a separator between parts of a single word, phrase, or value, that would otherwise be incomprehensible without the use of a separator.

[Rule 8-4]

Within a NIEM-conformant schema, any attribute declaration SHALL have a name that begins with a lower-case letter ('`a`'-'`z`').

[Rule 8-5]

Within a NIEM-conformant schema, any XML Schema component other than an attribute declaration SHALL have a name that begins with an upper-case letter ('`A`'-'`Z`').

[Rule 8-6]

The name of any XML Schema component defined by a NIEM-conformant schema SHALL use the camel case formatting convention.

[Rule 8-7]

A NIEM-conformant schema MUST consistently use approved acronyms, abbreviations, and word truncations within defined names. The approved shortened forms are defined in Table 2: Abbreviations used in NIEM Core Names .

[Rule 8-8]

A noun used as a term in a NIEM component MUST be used in singular form, unless the concept itself is plural.

[Rule 8-9]

A verb used as a term in a NIEM component MUST be used in the present tense, unless the concept itself is past tense.

[Rule 8-10]

Articles, conjunctions and prepositions SHALL NOT be used in NIEM component names, except where they are required for clarity or by standard convention (e.g.; `PowerOfAttorneyCode`).

[Rule 8-11]

Except as specified elsewhere in this document, any element or attribute defined within a NIEM-conformant schema SHALL have a name which takes the form:

- object class qualifier terms (0 or more)
- an object class term (1)
- property qualifier terms (0 or more)
- a property term (1)
- representation qualifier terms (0 or more)
- a representation term (1).

[Rule 8-12]

The object class term of a NIEM component SHALL consist of a term identifying a category of concrete concepts or entities.

[Rule 8-13]

A property term SHALL describe or represent a characteristic or subpart of an entity or concept.

[Rule 8-14]

Multiple qualifier terms MAY be used within a component name as necessary to ensure clarity and uniqueness within its namespace and usage context.

[Rule 8-15]

The number of qualifier terms SHOULD be limited to the absolute minimum required to make the component name unique and understandable.

[Rule 8-16]

The order of qualifiers SHALL NOT be used to differentiate names.

[Rule 8-17]

If any word in the representation term is redundant with any word in the property term, one occurrence SHOULD be deleted.

[Rule 8-18]

Within a NIEM-conformant schema, the name of an element declaration that is of simple content MUST use a representation term found in Table 3: Representation Terms.

[Rule 8-19]

Within a NIEM-conformant schema, the name of an element declaration that is of complex content, and which corresponds to a concept listed in Table 3: Representation Terms, MUST use a representation term from that table.

[Rule 8-20]

Within a NIEM-conformant schema, the name of an element declaration which is of complex content and which does not correspond to a concept listed in Table 3: Representation Terms, MUST NOT use a representation term from that table.

[Rule 8-21]

Within a NIEM-conformant schema, the name of an attribute declaration MUST use a representation term from Table 3: Representation Terms.

[Rule 8-22]

Within a NIEM-conformant schema, the name of any type definition MUST use the representation term `Type`.

[Rule 8-23]

Within a NIEM-conformant schema, the name of any simple type definition SHALL use the representation term qualifier `Simple`. This qualifier SHALL appear after any other representation term qualifiers.

[Rule 8-24]

Within a NIEM-conformant schema, the name of any code type SHALL use the representation term qualifier `Code`.

[Rule 8-25]

Within a NIEM-conformant schema, any type definition which has a base type definition of a code type or which is transitively based on a code type SHALL have a name which uses the representation term qualifier `Code`.

[Rule 8-26]

Within a NIEM-conformant schema, any association type SHALL have a name that uses the representation term qualifier `Association`. Types other than association types SHALL NOT use the representation term qualifier `Association`.

[Rule 8-27]

Within a NIEM-conformant schema, any augmentation type SHALL have a name that uses the representation term qualifier `Augmentation`. Types other than augmentation types SHALL NOT use the representation term qualifier `Augmentation`.

[Rule 8-28]

Within a NIEM-conformant schema, any metadata type SHALL have a name that uses the representation term qualifier `Metadata`. Types other than metadata types SHALL NOT use the representation term qualifier `Metadata`.

[Rule 8-29]

Within a NIEM-conformant schema, the name of any attribute group definition schema component SHALL use the representation term `AttributeGroup`.

[Rule 8-30]

Within a NIEM-conformant schema, the name of any reference element SHALL use the representation term suffix `Reference`.

[Rule 8-31]

Within a NIEM-conformant schema, the name of an association element SHALL use the representation term qualifier `Association.`

[Rule 8-32]

Within a NIEM-conformant schema, the name of an augmentation element SHALL use the representation term `Augmentation`.

[Rule 8-33]

Within a NIEM-conformant schema, the name of a metadata element SHALL use the representation term `Metadata`.

[Rule 8-34]

Within a NIEM-conformant schema, the name of a role SHALL use the property term `RoleOf`.

Appendix D. Name Syntax for Special Components

The following table summarizes NIEM general naming syntax for special components and their associated types. Refer to Sections 8.12 and 8.13 for the specific rules associated with this table.

Note this table does not mention the general syntax for standard types and properties introduced in Sections 8.12 and 8.13.

Table 4: Name Syntax for Special Components

Name Syntax *	**Notes**
Association	▨
[Property]Association	Preferred: [Property] describes relationship
[Object1][Object2]Association	Alternate 1: related objects
[Object]Association	Alternate 2: related objects are same class
Role Reference	▨
RoleOf[Object]Reference	Element in the role that references base type
Type Augmentation	▨
[Object][Property]Augmentation	[Object][Property] is from type augmented
Metadata	▨
[Property]Metadata	
Adapter	▨
[Object][Property]Adapter	
Abstract	▨
[Object][Property]	Preferred
[Object][Property]Abstract	Alternate: when required to prevent name clash

***** Object and Property refer to **[ISO 11179 Part 5]**terms in a component name.

Appendix E. Representation Terms

The following table lists the standard set of representation terms for use in the representation portion of NIEM-conformant component name. Refer to Section 8.11, Representation Term, for the specific rules associated with this table.

Primary Representation Term	**Secondary Representation Term**	**Definition**
Amount	-	A number of monetary units specified in a currency where the unit of currency is explicit or implied.
BinaryObject	-	A set of finite-length sequences of binary octets.
	Graphic	A diagram, graph, mathematical curves, or similar representation
	Picture	A visual representation of a person, object, or scene
	Sound	A representation for audio
	Video	A motion picture representation; may include audio encoded within
Code		A character string (letters, figures or symbols) that for brevity, language independence, or precision, represents a definitive value of an attribute.
DateTime		A particular point in the progression of time together with relevant supplementary information.
	Date	A particular day, month, and year in the Gregorian calendar.
	Time	A particular point in the progression of time within an unspecified 24 hour day.
ID		A character string to identify and distinguish uniquely, one instance of an object in an identification scheme from all other objects in the same scheme together with relevant supplementary information.

	URI	A string of characters used to identify (or name) a resource. The main purpose of this identifier is to enable interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols. A URI is either a Uniform Resource Locator (URL) or a Uniform Resource Name (URN). The specific syntax for each is defined by **[RFC3986]**.
Indicator		A list of two mutually exclusive Boolean values that express the only possible states of a property.
Measure		A numeric value determined by measuring an object along with the specified unit of measure.
Numeric		Numeric information that is assigned or is determined by calculation, counting, or sequencing. It does not require a unit of quantity or unit of measure.
	Value	A result of a calculation
	Rate	A representation of a ratio where the two units are not included.
	Percent	A representation of a ratio in which the two units are the same.
Quantity		A counted number of non-monetary units possibly including fractions.
Text	-	A character string (i.e. a finite sequence of characters) generally in the form of words of a language.
	Name	A word or phrase that constitutes the distinctive designation of a person, place, thing or concept.

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Appendix F. Documentation Standard Opening Phrases

This listing of standard opening phrases is informative only. For reference purposes, it repeats a table that appears in Section 6.2.1, Human-Readable Documentation.

ThisComponent Class	**Definition opening phrase**
Abstract	"A data concept for a …"
Association	"A relationship …"
Augmentation	"Supplements …"
Entities and properties of such	"A (An) …"
Indicator	"True if …; false otherwise/if…"
Role	"Acts as …"
Type	"A data type for …"
Role	"Acts as …"

Appendix G. NIEM Core Abbreviations

This listing of abbreviations used in NIEM Core is informative only. For reference purposes, it repeats a table that appears in Section 8.5, Use of Acronyms and Abbreviations.

Abbreviation	Full Meaning
ANSI	American National Standards Institute
CMV	Commercial Motor Vehicle
DEA	Drug Enforcement Agency
DNA	Deoxyribonucleic Acid
FGI	Foreign Government Information
FIPS	Federal Information Processing Standard
IC	Intelligence Community
ID	Identifier
IP	Internet Protocol
ISO	International Standards Organization
LIS	NCIC code list for license state
LSTA	NCIC code list for state/country index
MCO	Manufacturer's Certificate of Origin
MGRS	Military Grid Reference System
MSRP	Manufacturer's Suggested Retail Price
NANP	North American Numbering Plan
NCIC	National Crime Information Center
NCTC	National Counter Terrorist Center
NIBRS	National Incident Based Reporting System
NLETS	The International Justice & Public Safety Information Sharing Network (formerly known as the National Law Enforcement Teletype System)
ORI	Organization Identifier (Orion)
RES	NCIC code list for registration state for boat registrations
RF	Radio Frequency
SIM	Subscriber Identity Module
SSN	Social Security Number
TYP	NCIC code list for gun type
TYPO	NCIC code list for ORI type
URI	Uniform Resource Identifier
US	United States
UTM	Universal Transverse Mercator
VIN	Vehicle Identification Number
VINA	Vehicle Identification Number Analysis

Appendix H. Supporting Schemas

NIEM provides a set of schemas which underlie the data model schemas. These schemas do not define data model content; they don't define people, or vehicles, or relationships between them. Instead, these schemas define the fundamental framework on which the data model is built.

There are two supporting schemas. The first is called `appinfo`, and is the namespace for application information that supports data model definitions. The second is called `structures`, and is the namespace for basic types that augment the mechanisms of XML Schema for more sophisticated data modeling and information exchanges.

This appendix defines and discusses each of the framework components in the two supporting schemas. At the conclusion of the discussion of each schema, the full schema is provided as a reference.

This appendix also includes a directory listing of all the reference schemas that are part of NIEM 2.0.

The `appinfo` namespace

The `appinfo` schema provides support for high level data model concepts and additional syntax to support the NIEM conceptual model and validation of NIEM-conformant instances.

Schema document element

```
<xsd:schema
  xmlns:xsd=”http://www.w3.org/2001/XMLSchema”
  xmlns:i=”http://niem.gov/niem/appinfo/2.0”
  xmlns:s=”http://niem.gov/niem/structures/2.0”
  targetNamespace=”http://niem.gov/niem/appinfo/2.0”
  attributeFormDefault="qualified" version="1">
```

Discussion

The namespace for the `appinfo` namespace is `http://niem.gov/niem/appinfo/2.0`.

Element `appinfo:Resource`

```
  <xsd:element name="Resource">
    <xsd:complexType>
      <xsd:attribute name="name" type="xsd:NCName" use="required"/>
    </xsd:complexType>
  </xsd:element>
```

Discussion

The `Resource` element provides a method for application information to define a name within a schema, without the name being bound to a schema component. This is used by the `structures` schema to define names for `structures:Object` and `structures:Association`.

Element appinfo:Deprecated

```
<xsd:element name="Deprecated">
  <xsd:complexType>
    <xsd:attribute name="value" use="required">
      <xsd:simpleType>
        <xsd:restriction base="xsd:boolean">
          <xsd:pattern value="true"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:attribute>
    </xsd:complexType>
</xsd:element>
```

Discussion

The `Deprecated` element provides a method for identifying components as being deprecated. A deprecated component is one which is provided, but whose use is not recommended.

Element appinfo:Base

```
<xsd:element name="Base">
  <xsd:complexType>
      <xsd:attribute name="name" type="xsd:NCName" use="required"/>
      <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
  </xsd:complexType>
</xsd:element>
```

Discussion

The `Base` element provides a mechanism for indicating base types and base elements in schema, for the cases in which XML Schema mechanisms are insufficient. For example, it is used to indicate `Object` or `Association` bases.

Element appinfo:ReferenceTarget

```
<xsd:element name="ReferenceTarget">
  <xsd:complexType>
    <xsd:attribute name="name" type="xsd:NCName" use="required"/>
    <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
  </xsd:complexType>
</xsd:element>
```

Discussion

The `ReferenceTarget` element indicates a NIEM type which may be a target (that is, a destination) of a NIEM reference element. It may be used in combinations to indicate a set of valid types.

Element appinfo:AppliesTo

```
<xsd:element name="AppliesTo">
  <xsd:complexType>
    <xsd:attribute name="name" type="xsd:NCName" use="required"/>
    <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
  </xsd:complexType>
</xsd:element>
```

Discussion

The `AppliesTo` element is used in two ways. First, it indicates the set of types to which a metadata type may be applied. Second, it indicates the set of types to which an augmentation element may be applied.

Element `appinfo:ConformantIndicator`

```
<xsd:element name="ConformantIndicator" type="boolean"/>
```

Discussion

The `ConformantIndicator` element may be used in two ways. First, it is included as application information for a schema document element to indicate that the schema is NIEM-conformant. Second, it is used as application information of a namespace import to indicate that the schema is not NIEM-conformant.

Element `appinfo:ExternalAdapterTypeIndicator`

```
<xsd:element name="ExternalAdapterTypeIndicator" type="boolean"/>
```

Discussion

The `ExternalAdapterTypeIndicator` element indicates that a complex type is an external adapter type. Such a type is one that is composed of elements and attributes from non-NIEM-conformant schemas. The indicator allows schema processors to switch to alternative processing modes when processing NIEM-conformant versus non-NIEM-conformant content.

Full XML Schema for Appinfo Namespace

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:i="http://niem.gov/niem/appinfo/2.0"
xmlns:s="http://niem.gov/niem/structures/2.0"
targetNamespace="http://niem.gov/niem/appinfo/2.0"
attributeFormDefault="qualified" version="1">

  <xsd:element name="Resource">
    <xsd:complexType>
      <xsd:attribute name="name" type="xsd:NCName" use="required"/>
    </xsd:complexType>
  </xsd:element>

  <xsd:element name="Deprecated">
    <xsd:complexType>
      <xsd:attribute name="value" use="required">
        <xsd:simpleType>
          <xsd:restriction base="xsd:boolean">
            <xsd:pattern value="true"/>
          </xsd:restriction>
        </xsd:simpleType>
      </xsd:attribute>
      </xsd:complexType>
  </xsd:element>

  <xsd:element name="Base">
    <xsd:complexType>
        <xsd:attribute name="name" type="xsd:NCName" use="required"/>
        <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
    </xsd:complexType>
  </xsd:element>

  <xsd:element name="ReferenceTarget">
    <xsd:complexType>
      <xsd:attribute name="name" type="xsd:NCName" use="required"/>
      <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
    </xsd:complexType>
  </xsd:element>

  <xsd:element name="AppliesTo">
    <xsd:complexType>
      <xsd:attribute name="name" type="xsd:NCName" use="required"/>
      <xsd:attribute name="namespace" type="xsd:anyURI" use="optional"/>
    </xsd:complexType>
  </xsd:element>

  <xsd:element name="ConformantIndicator" type="xsd:boolean"/>
  <xsd:element name="ExternalAdapterTypeIndicator" type="xsd:boolean"/>

</xsd:schema>
```

The `structures` schema

The `structures` schema provides support for fundamental NIEM linking mechanisms, as well as providing base types for definition of NIEM-conformant types.

Schema document element

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema
    targetNamespace="http://niem.gov/niem/structures/2.0"
    version="1"
    xmlns:appinfo="http://niem.gov/niem/appinfo/2.0"
    xmlns:s="http://niem.gov/niem/structures/2.0"
    xmlns="http://www.w3.org/2001/XMLSchema">
```

Discussion

The target namespace for the `structures` schema is `http://niem.gov/niem/structures/2.0`.

Import of `appinfo`

```
  <xsd:import
    schemaLocation="../../appinfo/2.0/appinfo.xsd"
    namespace="http://niem.gov/niem/appinfo/2.0"/>
```

Discussion

The `structures` schema uses components from the `appinfo` namespace.

Resource `structures:Object`

```
  <xsd:annotation>
    <xsd:appinfo>
      <i:Resource i:name="Object"/>
    </xsd:appinfo>
  </xsd:annotation>
```

Discussion

The `Object` resource defines an identifier which acts as a conceptual base for objects in NIEM-conformant schemas.

Resource `structures:Association`

```
  <xsd:annotation>
    <xsd:appinfo>
      <i:Resource i:name="Association"/>
    </xsd:appinfo>
  </xsd:annotation>
```

Discussion

The `Association` resource defines an identifier which acts as a conceptual base for association in NIEM-conformant schemas.

Attribute `structures:id`

```
<xsd:attribute name="id" type="ID"/>
```

Discussion

The `id` attribute is used to define XML IDs for NIEM objects. These IDs may be targets of reference elements, metadata attributes, and link metadata attributes.

Attribute `structures:linkMetadata`

```
<xsd:attribute name="linkMetadata" type="IDREFS"/>
```

Discussion

The `linkMetadata` attribute allows an element to point to metadata that affects the relationship between the context and the value of the object.

Attribute `structures:metadata`

```
<xsd:attribute name="metadata" type="IDREFS"/>
```

Discussion

The attribute `metadata` allows an object to point to metadata that affects itself.

Attribute `structures:ref`

```
<xsd:attribute name="ref" type="IDREF"/>
```

Discussion

The `ref` attribute is used by reference elements in NIEM to refer to an object via an ID reference, rather than including the object itself as element content.

Attribute `structures:sequenceID`

```
<xsd:attribute name="sequenceID" type="integer"/>
```

Discussion

The `sequenceID` attribute allows a series of elements to define a sequence for content that does not correspond to the order of element declarations within a type. This attribute may override the sequence of elements appearing within an instance.

Attribute group `structures:SimpleObjectAttributeGroup`

```
<xsd:attributeGroup name="SimpleObjectAttributeGroup">
    <xsd:attribute ref="s:id"/>
    <xsd:attribute ref="s:metadata"/>
    <xsd:attribute ref="s:linkMetadata"/>
</xsd:attributeGroup>
```

Discussion

The `SimpleObjectAttributeGroup` attribute group provides a collection of attributes which are appropriate for definition of object types.

Element `structures:Augmentation`

```
<xsd:element name="Augmentation" type="s:AugmentationType”
  abstract="true"/>
```

Discussion

The `Augmentation` element provides a substitution group head for augmentations. The designer of a message or object may use this element within an object definition. This will allow the selection of augmentations dynamically, at run time (or at least schema selection time) rather than at schema authoring time.

Element `structures:Metadata`

```
<xsd:element name="Metadata" type="s:MetadataType" abstract="true"/>
```

Discussion

The `Metadata` element provides a substitution group head for metadata. Like the substitution group head for augmentations, this allows selection of metadata to be decided late in message creation, rather than at schema authoring time. This element may also be used to provide a single point in a container where all metadata for a message may be deposited.

Complex type `structures:AugmentationType`

```
<xsd:complexType name="AugmentationType" abstract="true">
  <xsd:attribute ref="s:id"/>
  <xsd:attribute ref="s:metadata"/>
</xsd:complexType>
```

Discussion

The `AugmentationType` type is a base type for all augmentations. An augmentation may have metadata and an ID, but may not have link metadata, as it does not establish a relationship between its value and its context. The individual element contents of an augmentation, however, do establish a relationship between the context of the augmentation and the values of the individual elements.

Type `structures:ComplexObjectType`

```
<xsd:complexType name="ComplexObjectType" abstract="true">
  <xsd:attribute ref="s:id"/>
  <xsd:attribute ref="s:metadata"/>
  <xsd:attribute ref="s:linkMetadata"/>
</xsd:complexType>
```

Discussion

The `ComplexObjectType` type provides a base class for object definition, association definitions, and external adapter type definitions. An instance of one of these types may have an ID. It may have metadata as it establishes the existence of an object (maybe a conceptual object). It may also have link metadata, as an element of one of these types establishes a relationship between its value and its context.

Type `structures:MetadataType`

```
<xsd:complexType name="MetadataType" abstract="true">
  <xsd:attribute ref="s:id"/>
</xsd:complexType>
```

Discussion

The `MetadataType` type is a base class for metadata type definition. This type provides only an ID, as the metadata may be referenced. It does not itself have metadata, and does not have link metadata.

Type `structures:ReferenceType`

```
<xsd:complexType name="ReferenceType" final="#all">
  <xsd:attribute ref="s:id"/>
  <xsd:attribute ref="s:ref"/>
  <xsd:attribute ref="s:linkMetadata"/>
</xsd:complexType>
```

Discussion

The `ReferenceType` type is the type of all reference elements within NIEM-conformant schemas. This type provides a reference attribute, to reference an object defined elsewhere. It includes an ID, as the link established by a reference element may need to be identified, and it includes link metadata, as an element of this type establishes a relationship between its context and the referenced object. It does not contain metadata, as it does not itself establish the existence of an object; it relies on a definition located elsewhere.

Full XML Schema for Structures Namespace

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema
  xmlns:xsd=”http://www.w3.org/2001/XMLSchema”
  xmlns:i=”http://niem.gov/niem/appinfo/2.0”
  xmlns:s=”http://niem.gov/niem/structures/2.0”
  targetNamespace="http://niem.gov/niem/structures/2.0"
  version="1">

  <xsd:import
    schemaLocation="../../appinfo/2.0/appinfo.xsd"
    namespace="http://niem.gov/niem/appinfo/2.0"/>

  <xsd:annotation>
    <xsd:appinfo>
      <i:Resource i:name="Object"/>
    </xsd:appinfo>
  </xsd:annotation>

  <xsd:annotation>
    <xsd:appinfo>
      <i:Resource i:name="Association"/>
    </xsd:appinfo>
  </xsd:annotation>

  <xsd:attribute name="id" type="xsd:ID"/>
  <xsd:attribute name="linkMetadata" type="xsd:IDREFS"/>
  <xsd:attribute name="metadata" type="xsd:IDREFS"/>
  <xsd:attribute name="ref" type="xsd:IDREF"/>
  <xsd:attribute name="sequenceID" type="xsd:integer"/>

  <xsd:attributeGroup name="SimpleObjectAttributeGroup">
    <xsd:attribute ref="s:id"/>
    <xsd:attribute ref="s:metadata"/>
    <xsd:attribute ref="s:linkMetadata"/>
  </xsd:attributeGroup>

  <xsd:element name="Augmentation" type="s:AugmentationType"
    abstract="true"/>
  <xsd:element name="Metadata" type="s:MetadataType" abstract="true"/>

  <xsd:complexType name="AugmentationType" abstract="true">
    <xsd:attribute ref="s:id"/>
    <xsd:attribute ref="s:metadata"/>
  </xsd:complexType>

  <xsd:complexType name="ComplexObjectType" abstract="true">
    <xsd:attribute ref="s:id"/>
    <xsd:attribute ref="s:metadata"/>
    <xsd:attribute ref="s:linkMetadata"/>
  </xsd:complexType>

  <xsd:complexType name="MetadataType" abstract="true">
    <xsd:attribute ref="s:id"/>
  </xsd:complexType>

  <xsd:complexType name="ReferenceType" final="#all">
    <xsd:attribute ref="s:id"/>
    <xsd:attribute ref="s:ref"/>
    <xsd:attribute ref="s:linkMetadata"/>
  </xsd:complexType>

</xsd:schema>
```

NIEM 2.0 Reference Schemas – Directory Listing

```
niem
│
├───ansi-nist
│   └───2.0
│           ansi-nist.xsd
│
├───ansi_d20
│   └───2.0
│           ansi_d20.xsd
│
├───apco
│   └───2.0
│           apco.xsd
│
├───appinfo
│   └───2.0
│           appinfo.xsd
│
├───atf
│   └───2.0
│           atf.xsd
│
├───census
│   └───2.0
│           census.xsd
│
├───dea
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│   └───2.0
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│   │       ├───om
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│   │       │               om.xsd
│   │       │               procedure.xsd
│   │       │               procedureSpecializations.xsd
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│   │       └───dhs-gmo
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│   │                   sweCommon.xsd
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├───fips_5-2
│   └───2.0
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│           iso_639-3.xsd
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├───itis
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│           itis.xsd
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├───mmucc_2
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```

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├───twpdes
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│           twpdes.xsd
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├───ucr
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│           usps_states.xsd
│
└───ut_offender-tracking-misc
    └───2.0
            ut_offender-tracking-misc.xsd
```

Appendix I. References

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Appendix J. Glossary

This glossary is informative only. It collects together all the definitions which appear in the preceding document, for the benefit of those reading a hardcopy of this document.

adapter type

An **adapter type** is a NIEM-conformant type that adapts external components for use within NIEM. An adapter type creates a new class of object that embodies a single concept composed of external components. An adapter type is defined by a NIEM-conformant schema.

application information

A component is said to have **application information** of some element **E** when the root element that defines the component has an immediate child element `xsd:annotation`, which has an immediate child element `xsd:appinfo`, which has as an immediate child the element **E**.

appinfo namespace

The **appinfo namespace** is the namespace represented by the URI "`http://niem.gov/niem/appinfo/2.0`".

association

In a NIEM-conformant schema, an **association** is an element whose type is a association type.

association type

In a NIEM-conformant schema, an **association type** is a type which establishes a relationship between objects, along with the properties of that relationship. An association type provides a structure which does not establish existence of an object, but instead specifies relationships between objects.

augmentation

An **augmentation** of a NIEM-conformant object type is a block of additional data added to an object type, in order to carry additional data beyond that of the original object definition.

augmentation type

An **augmentation type** is a complex type which provides a reusable block of data which may be added to object types or association types.

code type

A **code type** is a simple type schema component definition which contains multiple `xsd:enumeration` facets.

definition

The **definition** of a documented component is the content of the occurrence of an element `xsd:documentation` that is an immediate child of the occurrence of an element `xsd:annotation`. That element `xsd:annotation` is itself an immediate child of the element that defines the component.

deprecated component

In a particular NIEM-conformant namespace, a **deprecated component** is one whose use is not recommended, yet which is maintained in the schema for compatibility with previous versions of the namespace.

documented component

In a NIEM-conformant schema, a **documented component** is an XML Schema component that is required to have associated documentation. These schema components are required to have a textual definition for the component to be well-understood. Schemas that do not document their components accordingly are not NIEM-conformant.

external schema

An **external schema** is any non-supporting schema that is not NIEM-conformant.

metadata element

Within a NIEM-conformant schema, a **metadata element** is an element whose type is a metadata type. There are specific limitations on the meaning of a metadata element in an instance; it does not establish existence of an object, nor is it a property of its containing object.

metadata type

A **metadata type** describes data about data, that is, information which is not descriptive of objects and their relationships, but is descriptive of the data itself. It is useful to provide a general mechanism for data about data. This provides required flexibility to precisely represent information.

NIEM-conformant document

A **NIEM-conformant document** is an XML information set whose document element is defined by a NIEM-conformant schema, and which follows the rules for conformant element information items as specified by this document.

NIEM-conformant element instance

A **NIEM-conformant element instance** is an XML information item which is defined by a NIEM-conformant schema, and which follows the rules for conformant instance data as specified by this document.

NIEM-conformant schema

A **NIEM-conformant schema** is an XML document which follows the rules for NIEM-conformant schemas, as provided by this document. Any schema that follows all of the rules may be called NIEM-conformant.

object type

In a NIEM-conformant schema, an **object type** is a complex type definition, an instance of which asserts the existence of an object. An object type represents some kind of object: a thing with its own lifespan that has some existence. The object may or may not be a physical object. It may be a conceptual object.

reference element

A **reference element** is an element that refers to its value by a reference attribute, instead of carrying it as content.

RoleOf element

In a NIEM-conformant schema, a **RoleOf element** is a reference element whose type is the base type of the role.

role type

A **role type** is a type that represents a particular function, purpose, usage, or role of an object.

structures namespace

The **structures namespace** is the namespace represented by the URI "`http://niem.gov/niem/structures/2.0`".

Appendix K. Notices